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AUGUST 8, 9, & 10.

British Foundrymen's Association.—Annual Convention at Glasgow.

NOTES AND COMMENTS.

Firebricks and the Effect of Heat.

The discussion on "The Action of Heat on Fireclays," which we report on page 399 of this issue, recalls an interesting paper presented before the International Congress at Düsseldorf last year by Dr. Blasberg. The subject is an important one in connection with most metallurgical operations, for the increasingly high temperatures employed place great difficulties in the way of providing suitable fireproof materials. At present, temperatures exceeding 1,800 degrees C. are by no means rare, and in the electric furnace they are still higher. This, however, would not be prohibitive if it were the sole factor to be considered, since firebricks with a fusing point of 1,850 degrees C. are already produced, whilst most processes are carried on at much lower temperatures; but other influences have to be reckoned with, except in very rare instances. The chief constituents of these fireproof materials are alumina and silica, in varying proportions, usually accompanied by the fluxing ingredients—iron oxide, lime, magnesia, and the alkalis. Though refractory in themselves, these bases form with silica readily fusible silicates, and thus impair the fire-resisting properties of the material. A similar effect is produced by other metallic oxides when brought into contact with the fireproof material at the temperature of incandescence. The mineral constituents of coal produce the most extensive and best-known destruction of fireproof materials in the boiler furnace, the clinkering of the fuel gradually corroding the fireproof linings, whilst the ash constituents of coal also play an important part in smelting and similar processes where the fuel comes in direct contact with the fireproof lining. In these latter cases, however, the process is less simple than in boiler furnaces, since they form only a portion of the decompositions that take place, the ore gangue and gases (both generated and supplied) being also actively concerned.

In Dr. Blasberg's paper were quoted analyses of several kinds of fireproof brick from blast furnaces, cupolas, etc. These analyses, generally, indicated an increase in the percentage of alkalis, which collect more particularly in the case of blast-furnace linings. One example, a cupola brick, showed a considerable increase of alkalis and iron oxide. Analyses of silica-bricks from an open-hearth furnace, where they were, naturally, exposed to very high temperatures, coupled with the corrosive influence of fluxes, showed that the corroded bricks had chiefly increased in iron oxide, lime and alumina, the enrichment in magnesia and alkalis being comparatively slight. The only constituent that had diminished was the silica, mostly to a considerable extent. Under the high temperature prevailing in the furnace, it is not improbable that both changes may be due to simultaneous volatilisation of some kind, the researches of Cramer having shown that silica itself is volatile at a strong white heat. On the other hand, Dr. Blasberg found diminutions in the silica content of Dinas bricks, though the temperature to which they were exposed was much below that in the open-hearth furnace,

Whitish clouds, due to volatilised silica, are frequently seen during the tapping of the open-hearth furnace; and it is not impossible, he considers, that this silica may partly originate in the furnace vault bricks, as well as from the metal. The destruction of Dinas brick usually commences by a slight browning of the mass. The fine particles between the coarser fragments of quartite coalesce, and at the same time the angular shape of the quartaite is altered, and the colour changed from grey to white. The matrix deepens progressively in colour, and the white quartzite becomes smaller and smaller until it vanishes entirely in the black mass. Prolonged exposure of the latter to a high temperature, however, often causes it to become paler (grey), probably owing to the combustion of a portion of the carbon of which the colouring matter consists. The property of Dinas bricks to expand by about 3½ per cent. on heating, facilitates their destruction. This expansion is apparently due to the transformation of the silica from the crystalline condition (sp. gr. 2.6) into the amorphous state (sp. gr, 2.2), *i.e.* with an increase in volume. Another cause of the expansion is the enlargement of the interstitial pores, the bricks becoming looser in texture and capable of absorbing a considerable amount of extraneous substances which, being basic, combine with the silica, and reduce the fusing point of the entire mass. Hence, the bricks can no longer resist the high temperature, and fuse. The temperature of the open-hearth furnace may be taken as about 1,850 degrees C., high enough to soften even silica brick, which is the best material for lining the vaults of these furnaces. In that condition the bricks will absorb with avidity all the basic substances present in the gas space of the furnace; and the resulting incorporation of these substances in large amount seals the fate of the bricks. It will, therefore, be seen that the action of heat on even the best of bricks is an important matter for the steel founder, for the movement set up in the reaction space by the combustion of the producer gas, and by the rapid escape of the products of combustion, cannot protect the furnace vault from the impact of splashings from the charge during the introduction of fresh material into the furnace, nor can it prevent the formation of flue ash. Nevertheless, everything possible should be done to render this movement harmless, on the one hand by allowing it sufficient opportunity to subside, and on the other by using fuel low in ash for the producer, and lining the furnace vault with bricks that are high in silica.

Phases of Foundry Progress.

Year by year as the march of technical progress steadily proceeds, we find different phases of the great problem of how to produce the ideal casting, each being presented in turn, and each likewise pressed forward by its supporters as being the crux of the whole matter. At one time it is the coke question which is the dominating feature, at another the blast pressure or the shape of the furnace bosh; and while we are endeavouring to catch a glimpse of the light of success which is said to be veiled by bad practice in these directions, a new prophet arises in the land, and for a time we are impressed with the necessity of grading and mixing our metal by analysis; the chemist must have control, and by the judicious application of his fairy wand of "scientific methods," the evils that have vexed the foundry manager will be nullified. So we waver between the assertions of different specialists, not excluding those who respectively put forward the claims of moulding sand mixers, special core compounds, etc. But like most specialists, their views are generally a little out of true perspective, and it is necessary to first apportion to each its meed of importance, so that the whole may evolve a harmonious system; for to be run by a specialist in any one department is akin to a direct application for trouble in nearly every other direction. When considering the question of defective castings, the circumstances and conditions existing in the particular foundry usually need special attention; for an unhappy combination of practices which individually may not cause material trouble, has often been found to be the root of a large scrap heap. But there are several general principles which may be accepted as applying to most foundries, and opinion is steadily forming in favour of a correct combination of factors as the road to success, rather than attention to any one department. In a paper presented before the American Foundrymen's Convention it was put forward by Mr. J. M. Perkins that the problem of reducing the percentage of defective castings should first be conidered in the drawing office, as there are many details, seemingly of no importance to the engineer, which should be considered from the foundryman's viewpoint. The pattern-maker should consult with the foundryman before making his patterns, and after the pattern has been completed the foundry man should consult with the coremaker, the moulder and the cleaning room foreman as to the best method of procedure. He sums up the factors essential to a lowering of the percentage of rejected castings as follows:—(1) A sand from which good castings can be made; (2) combinations of ideas of all interested in the making of a casting, so as to obtain the best equipment; (3) a substantial incentive offered for good work; (4 the despatch of the castings in as good a condition as when they left the shop; (5) a clean, well-equipped shop. These are all important factors, and if there be added (6) a knowledge on the part of the manager of the chemical composition and conduct under heat of metals; (7) a good knowledge of the relationship between coke, furnace, metal and blast on the part of the cupola man, and (8) an absence of the inclination (not uncommon) to economise on the materials of the foundry at the expense of quality, the chances of maintained success are considerable. It is, perhaps, only natural that undue importance should be laid on various of the foregoing factors at times, but it is distinctly promising to find harmony of ideas included in the list, How many foundry owners quite ignore this important item?

The Electric Furnace in the General Foundry.

In recent discussions on electric furnace possibilities, the application of that furnace to steel work has received the lion's share of attention. But, as pointed out by Dr. Paul Héroult, a more interesting feature of the electric furnace (to the general founder) is that it is capable of improving the quality of foundry iron, and this at very low cost and by a very simple operation. The main feature of what is called strong iron is the low content of sulphur, and the removal of sulphur is one of the easiest and most effective operations that can be performed in the electric furnace. It consists simply in pouring into the furnace a charge of molten pig-iron, if possible direct from the blast furnace; if not, from a cupola or other melting apparatus, then heating the metal under a basic slag which does not have to be scraped or removed except when it is teemed into a ladle with the metal ready for pouring. The contents in carbon, silicon, manganese, and phosphorus are not affected by this operation unless this be desired. Common Bessemer iron, Dr. Héroult says, can be changed into strong iron, charcoal iron, car-wheel iron, or so-called cold-blast charcoal iron for a cost of about 4s. per ton. It seems probable that on account of the high grade of material so cheaply produced, most iron castings of the future will be made of this electrically-treated iron. This product will help to give new life to the iron foundry industry, and will enable it to compete with the steel-casting industry.

Mechanical Moulding.*

By Thos. D. Wilson,

Moulding machines were constructed, in the first place, to meet the demand for castings of a class that were required in large quantities, and of uniform design, such as the round shot and shell used up to and during the Crimean War. Machines for such work were of a very simple character, and their construction did not afford the moulder much relief, so far as his arduous manual labour was concerned. Over 50 years ago a Middlesbrough firm built and equipped a foundry solely for the casting of railway chairs, and it was there the writer saw and worked a "Knight's" machine for chair moulding; but the initial attempt was scarcely a success, as it was quite within the power of a strong youth to keep pace with the output of the machine. In the course of time, however, there were many improvements in its construction, and eventually it took the place of ordinary hand moulding by producing far greater quantities, also better and more uniform castings.

matically executed which is now done by hand. The cost of pattern plates and stripping plates, the making of which requires a great amount of skill and time, has no doubt been one of the deterrents to the more extensive use of machines in the general foundry.

Having had the privilege of a visit to Messrs. Greenwood & Batley, Leeds, where a foundry is entirely equipped with machines for the production of a varied class of castings in both iron and brass, I was struck with, not only the rapidity of production, but with the perfect finish of both moulds and castings. In some cases the castings were of a very complicated character, and these were produced by unskilled labour at a very low cost. The perfections of such machines must be credited to the engineers who, having grasped the requirements of the foundry, have applied their skill, ingenuity and ability in designing machines suitable to their various wants.

In machines of this description the actual moulding

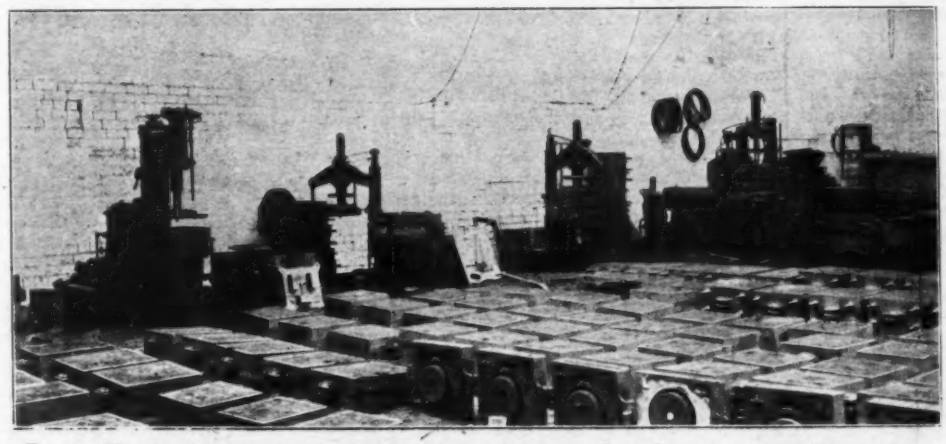


FIG. 1.—VIEW IN FOUNDRY OF MESSRS. GREENWOOD & BATLEY, LTD., LEEDS; SHOWING BONVILLAIN AND RONCERAY MACHINES.

Since that period there has been a great advancement in the adoption of mechanical moulding. The old machine with its cams, levers, and links, has been replaced by direct power, hydraulic being the most general. Compressed air is in use in some foundries, but hydraulic power is preferable by reason of its first cost and maintenance, a 1 h.p. plant being sufficient to work several light machines.

In the United States, the great demand for duplicate machinery for wood working, and more especially for agricultural purposes, coupled with the high rate of wages, created a strong incentive to the designing and application of moulding machines. The most notable of the machines produced is the "Pridmore," a large number of this type having been adapted to meet a wide and varied class of work. Machine moulding, it may be mentioned, is far more in evidence in America than with us. There are several makers of good machines in this country, and firms who can make their own machines for special castings very successfully, but there is no machine capable of doing all the operations of hand moulding. Such a machine does not exist, though in future much may be auto-

plant, as a supplement to the machine—that is the stripping plate, the reversible pattern plate, the double pattern plate and the reversible Cliche process—are all within the power and skill of an intelligent moulder with an eye for accuracy, to make for himself, without the aid of a mechanic. All that is requisite to make the pattern plate is the ordinary wood pattern, and from it the pattern plate may be made, by a very ingenious method a plaster plate for small numbers, or in the case of 100 or more, of a non-shrinking metal alloy. A coat of varnish on the plaster plate or a little rubbing with emery cloth for the alloy plate is all that is necessary to prepare them for the moulding machine. The following description together with the illustrations will explain many ingenious features to those who are interested in foundry work.

Fig. 2 shows a reversible pattern plate, stripping-plate and castings of motor cycle cylinders. The pattern-plate is fixed on the machine with its stripping plate in position. A flask is placed on the top of the stripping-plate, filled with sand, and then rammed by one stroke of the machine. The flask and stripping-plate are now lifted by four stools, which engage under the four corners of the stripping-plate, operated

* Abstract of Lecture delivered before the Cleveland Institution of Engineers.

by a ram in the lower part of the machine. Twenty castings per hour have been produced from this pattern plate by two unskilled men, on one A3 moulding machine, boxes 21 in. by 14 in.

Fig. 3 shows a double pattern-plate, stripping-plate and loose pieces, with castings of a B.T.H. dynamo

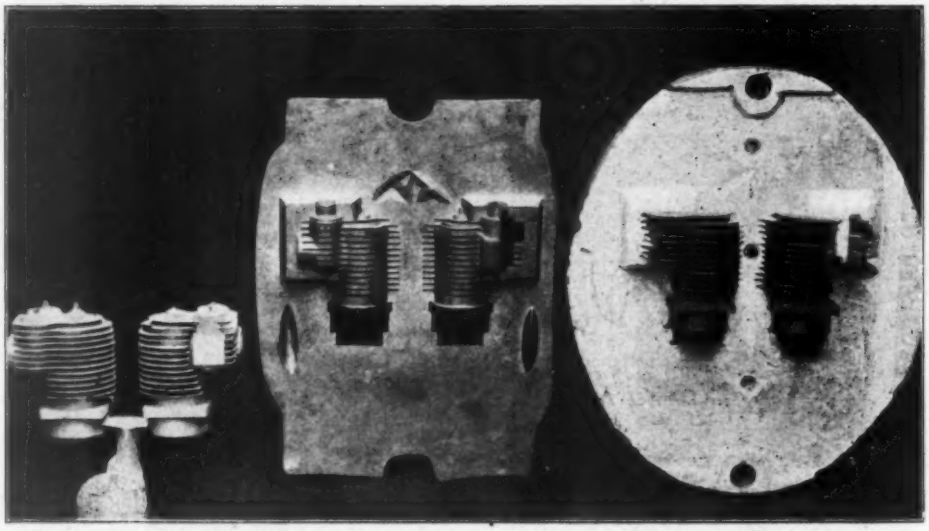


FIG. 2.—REVERSIBLE PATTERN PLATE AND STRIPPING PLATE, AND CASTINGS OF MOTOR CYLINDERS.

spider. Three castings per hour are produced from this pattern-plate by two unskilled men on two A3 machines. The double pattern-plate process consists in putting one part of the pattern on one pattern-plate, and the other part on another pattern-plate, and requires the use of two machines, one for the drag and the other for the cope. It is adopted for large or very deep castings.

The hand-lever power moulding machine is operated by a hand-lever which, acting through a combination of levers, gives a heavy pressure on the ramming head. It consists of a table upon which the pattern plate is fixed so that a flask may be placed above it, and filled in with sand ready for ramming. The lower part of the table contains a stripping cylinder and ram with a stripping table attached to its upper part carrying four adjustable rods which engage at the underside of the stripping plate. This ram is actuated by oil passing through a pipe from a local cylinder, fixed on the base of machine, which by the action of its own ram conveys oil into the stripping cylinder. When the hand-lever is pulled down it brings the power head into a vertical position, which then descends and rams the mould. On the comple-

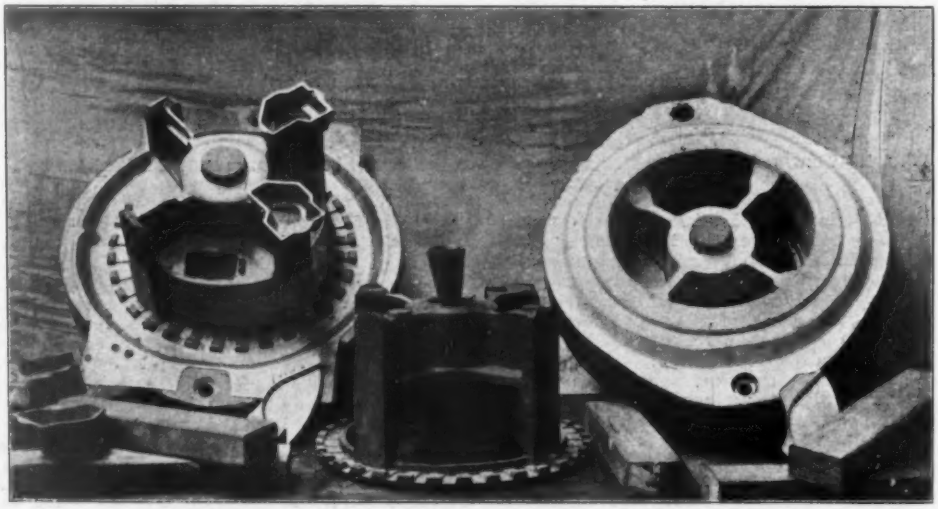


FIG. 3.—DOUBLE PATTERN PLATES, STRIPPING PLATE AND LOOSE PIECES.

tion of ramming, the hand-lever is released, causing the ramming head to rise and fall back into an angular position. The ram in the local cylinder is now pressed down, forcing oil into the stripping cylinder, which lifts the ram and strips the pattern-plate with its flask, which can then be lifted off. By reversing

this action the stripping ram descends with the stripping plate, when another flask is placed in position, and the operations are repeated.

The standard universal hydraulic moulding machine with power ramming head and revolving sand filler (swung out of position), is shown in Fig. 4. This machine consists of a table having a large hole in its upper surface, which contains movable bars for supporting the pattern plate, and also to facilitate a clearance for loose stools for internal stripping. The pattern-plate is fixed by two studs. The upper part of the studs serves to locate the flask in position on the pattern-plate. A swinging power ramming head is mounted on a hollow column fixed on one side of the

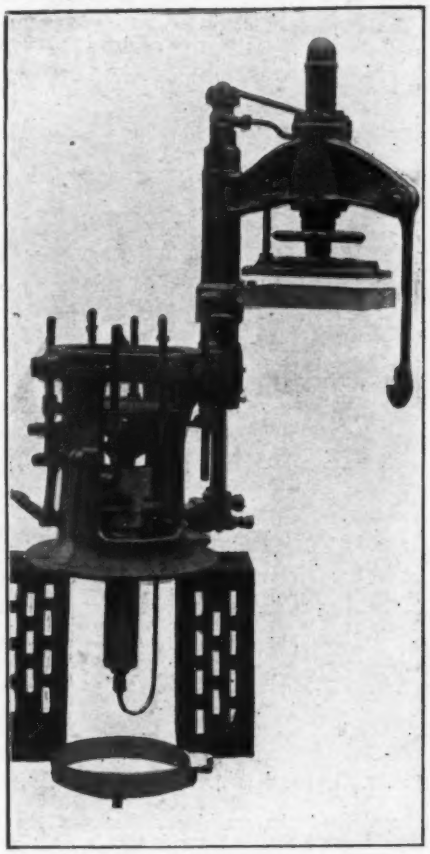


FIG. 4.—STANDARD UNIVERSAL HYDRAULIC MOULDING MACHINE.

table, which contains the power ram with an adjustable socket and ram plate to give variable distance between ram plate and pattern plate, so as to obviate unnecessary movement of the ram. The ram is operated by a valve fixed on one side of the swinging head, the pressure and exhaust water passing through pipes through the hollow column, from a main valve fixed to the base of the machine. After ramming, the power ram is returned to its original position by a constant-pressure return ram connected direct to the power ram, working in a small cylinder fixed directly on the top of the power-ram cylinder in the swinging head. This head swings on ball bearings to give an easy movement, and is provided with a hook at the opposite end to the column. This hook engages in a slot in the table when the head is swung into position, which holds and supports the head during the ramming operations.

In the base of the table is fixed a stripping cylinder having a ram with a stripping table attached to its upper part carrying stool brackets with adjustable stools for engaging under the stripping plate. The ram is actuated by the movement of a foot pedal in front of the machine, which operates a valve in the main distribution valve, thus causing the ram to ascend and descend, stripping the pattern with its flask, and then returning it to its original position. The stripping ram is made adjustable in its stroke by a suitable nut and adjustable rods, to give an exact movement to the stripping plate in accordance with the pattern. A double ramming device is provided, operated by a foot pedal located in front of machine, which engages in a socket and gives an additional

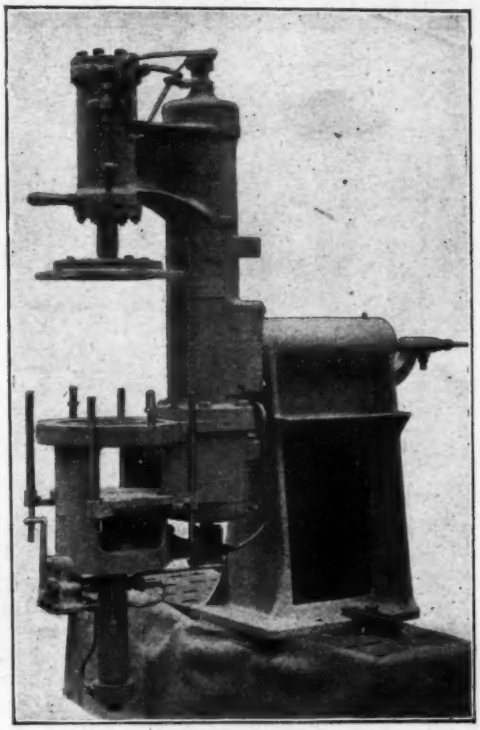


FIG. 5.—STANDARD ROTARY HYDRAULIC MOULDING MACHINE.

pressure, if necessary, from the bottom of the mould to a certain part when under pressure from the top, as for instance, deep core holes.

The machine is operated as follows:—An empty flask is put on the pattern-plate, the revolving sand filler swung into position and filled in with sand. The power ramming head is now swung into position and the mould rammed. The head with the sand filler is then swung out of position, the foot pedal pressed down, stripping the pattern, when the finished mould is lifted off. The stripping-plate now descends, and the same operations are repeated.

The standard rotary hydraulic moulding machine illustrated in Fig. 5, is generally similar to the machine already described for ramming and pattern drawing, but in addition is mounted upon a trunnion and may be swung into an upside-down position. The arrangement is intended for use in cases where heavy pockets of sand have to be lifted. Although castings

involving such pockets can be moulded on the standard universal type of machines, it is necessary to strengthen the sand by the use of gaggers, which entails a considerable loss of time. This is obviated by the use of rotary machines, where these gaggers can be dispensed with, thus increasing rapid production. This machine is rotated by hand and is shown in position for ramming.

When the machine is in operation, a pattern-plate is placed in position with an empty flask on the top, which is filled in with sand and rammed in the same manner as the standard universal machines. With the ramming pressures still on, the machine is revolved round its trunnion into an upside-down or reversed position. The ramming cylinder is then put to exhaust, and the mould drawn, but this drawing is helped by the opposite stripping ram acting as another pattern-drawing ram, which is connected with

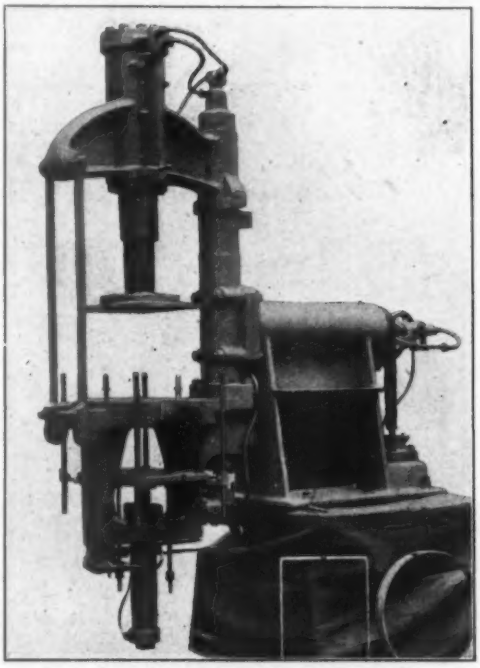


FIG. 6.—STANDARD ROTARY HYDRAULIC MOULDING MACHINE.

stools, stripping plates, etc. As soon as the mould is out of danger, this stripping ram is stopped and the power ram continues lowering until the mould is entirely drawn from the pattern. The lowering is then stopped by an automatic device, the head swung out of the way and the mould taken off.

Fig. 6 is a larger size in the same type of machine, and it is revolved hydraulically by a chain passing over a toothed wheel fixed at the end of the trunnion shaft and actuated by two rams connected to each end of chain.

A hydraulic assembling machine for assembling difficult moulds of thin castings with deep recesses and cores, which are difficult to assemble by hand owing to the likelihood of the moulds rubbing the cores, etc., against the sides of the moulds, when moulding such castings in green sand, is shown in Fig. 7. This machine is also used for working the "Motte" system by pushing the sand moulds out of the flasks, as shown in our illustration, and only requires one pair of flasks for making any number of moulds to be placed on the floor ready for pouring. This is quite a new departure in machine moulding, as it assembles a mould accurately and produces complete moulds ready for pouring with only one pair of flasks. This dispenses with snap flasks, which are being used for the same purpose. As the latter are soon liable to get out of order when moulding in "Mottes," an internal band of hoop iron is put in the flask, which lies about ¼ in. below the circumferential surface of the mould, and holds it together during the pouring process. Before pushing out the "Motte" a thin plate is put on the ram table for the purpose of supporting and carrying the "Motte" on the floor.

The assembling machine consists of a foundation plate with T slots carrying two vertical fork-shaped rests which are fixed down by bolts sliding in the slots, and whose position may be adjusted in reference

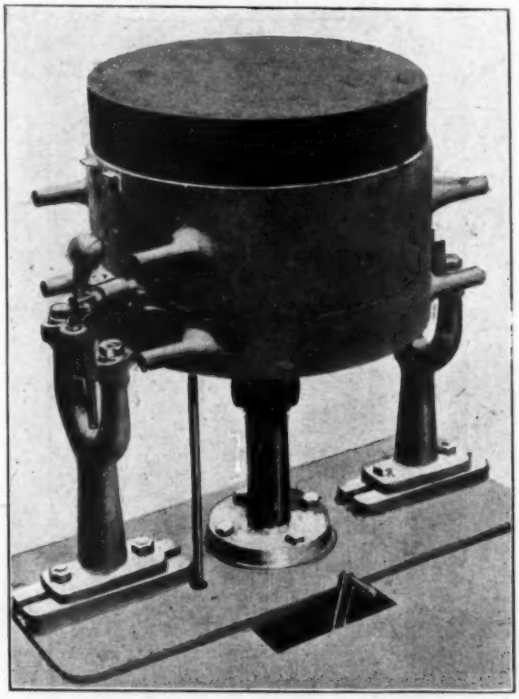


FIG. 7.—HYDRAULIC ASSEMBLING MACHINE.

to the centre of the machine. Between the two branches of the forks, but set inward a little from their centre lines, are fixed vertical rods which engage with the holes of the flasks and so register them. Behind these rods and right in the centre of the forks are two small vertical moving rods, which are connected up by steel wire cords at their lower ends to balance weights situate below the foundation plate of the machine. The weights are proportioned to be heavier than an empty flask, but lighter than one filled with sand. Two locks are fixed on both fork ends, operated by short ball-headed hand levers. At the centre of the machine a circular table is fitted and carried at the top of a vertical hydraulic ram working in a cylinder fixed in the foundation plate of machine. The ram is controlled by a valve from a hand-lever in the lower part of the machine, and has an automatic stop to prevent its lifting too high. When the machine is being used for assembling, the lower flask or drag is placed joint upwards on the table of the hydraulic ram, which is raised to the

top of its stroke. The holes in the flask engage in the fixed guide rods on the forks, when the hand-lever of the valve is operated which lowers the ram and carries the flask with it. The lugs on the flask engage on the sliding vertical rods inside the forks, and owing to the flask being filled with sand its weight depresses them and lifts the balance weights. The upper flask or cope is now placed in position, joint downwards on the guide rods, so that its lugs rest on the top of the forks. The locks are then operated, the upper flask being locked in position. The valve is now operated, allowing water to pass at the underside of the ram, which rises and lifts the lower flask accurately into position against the upper one, assembling the complete mould together, and when assembled the ram knocks off automatically.

If "Mottes" are being produced, the lift of the ram continues until it has pushed the complete sand mould out of the pair of flasks, when the "Motte" may be lifted on to the floor ready for pouring. The locks are then released and the balance weights lift the empty flasks, which are now removed, and the machine is ready for a fresh cycle of operations.

The whole of the plant described herewith was manufactured by Messrs. Greenwood & Batley, Limited, Leeds.

Titanium in Steel Castings.*

By Charles V. Slocum.

Practically all steel-makers endeavour to fully deoxide their steel by using more or less of the well-known deoxidizers, manganese and silicon. The melters also try to remove other shortcomings with these elements. For instance, the metal is sometimes overheated and then the melter tries to bring the steel back to normal conditions by adding more manganese or more silicon, or both, perhaps, occasionally making the steel too high in these elements to pass the specifications or too full of blow-holes to pass the shop inspection. Sometimes one of these same heats, thus spoiled, is one in which titanium is later added and the failure is charged to this element, which could have saved the heat had it been used in sufficiently large proportions of 1 per cent. or more and at the proper time.

One great advantage of the regular use of titanium alloy is that it removes those features of irregularity which have given steel a bad name for its unreliability in a number of directions. In a recent trial of titanium alloy in a basic open-hearth plant it was found that in order to remove the last vestige of brittleness and of blow-holes the use of 1½ per cent. of the alloy was necessary. This, in turn, made the steel so dense that it was unusually strong.

Good Foundry Practice and Sinking Heads.

It is not possible to remove all of the causes of poor castings by the addition of titanium, nor with any alloy whatever. Good foundry practice is more essential in steel than in iron, because more harm is likely to result if the castings are not as good as they should be. When the mould is not properly made or baked; when the mixture is not properly estimated and prepared; when the melt is not looked after to prevent overheating, etc., it all comes back to the original claim that other things are necessary as well as the use of alloys, for good steelmaking.

When we learn that in some foundries a sinking head is cast which weighs considerably more than the casting itself, and the latter, in some instances, weighs eight tons, then we see, at once, that foundry practice has given way to the sinking head, and it is a wonder the casting itself does not give way as well. Compare the cost of a nine-ton sinking head to make an eight-ton casting with the cost of titanium alloy in sufficient quantity to remove the blow-holes which the big sinking head removes, and it figures out about as follows, with castings at 1.75d. per pound and scrap at 0.38d. per pound.

	£	£
Nine ton head, 2,000 x 9 x 0.035 =	126	
Less scrap value, 2,000 x 9 x 0.0075 =	27	
		99
Maximum head of 40 per cent. by using titanium, 2,000 x 8 x 0.40 x 0.035	45	
Cost of 1 per cent. titanium alloy for eight-ton casting and 40 per cent. head, 22,400 x 1.00 at 12½ cents	6	
		51
Difference in favour of titanium		48

When we take into consideration the fact that so small a proportion as one-tenth of 1 per cent. of titanium alloy makes a noticeable improvement in steel, and that larger proportions up to 2 per cent. add materially to the improvement, then it becomes clear that the small cost involved, from 1s. as the minimum to £1 3s. per gross ton of product as the probable maximum, is a factor which every steel manufacturer should consider.

Titanium in Open-Hearth Steel.

The following proportions have been used regularly in a steel plant where only the best results are accepted and where the product is said to be equal to the best stamping steels made in America:—

Size of heat, 120,000 pounds

	Carbon. Per cent.	Manganese. Per cent.	Phosphorus. Per cent.	Sulphur. Per cent.
Analysis ...	0.10	0.33	0.007	0.019

Titanium alloy added in ladle, 250 pounds = 0.21 per cent, or 0.021 per cent titanium.
Aluminium added, 10 pounds = 0.01 per cent.
Elastic limit, 37,060 pounds per square inch after dead soft anneal.
Tensile strength 44,920 pounds per square inch, after dead soft anneal.
Elongation in 2 inches, 40 per cent.
Elongation in 4 inches, 28 per cent.
Reduction of area, 56.4 per cent.
Fracture, silky.

In one of the most noted steel works in the world, steel castings are required of the following specifications:—Elastic limit, 45,000 pounds per square inch; tensile strength, 85,000 pounds per square inch: elongation after rupture, 12 per cent.; contraction of area, 18 per cent. These specifications have been met and the necessity for numerous heat treatments has been avoided by the use of eight pounds of titanium alloy per ton of metal added in ladle. No aluminium was used.

Regarding the use of titanium this concern has written as follows:—"Comparing the results of the tests made upon specimens after the first anneal of the last 15 heats in which ferro-titanium was used, with those of the last 15 previous heats in which it was not used, it appears that the mean tensile strength was increased from 81,633 pounds per square inch to 91,533 pounds per square inch, that the mean elastic limit was increased from 47,233 pounds per square inch to 50,000 pounds per square inch, that the mean elongation was increased from 15.1 per cent. to 19.2 per cent., and that the mean contraction of area was increased from 1.9 per cent. to 24.3 per cent."

The general manager of the Keystone Steel Castings Company, Chester, Pa., strongly recommends the use of steel, so treated, for automobile work where the castings are subject to unusual shocks and where uniformity of material is absolutely essential.

* Presented at the Pittsburg Convention of the American Foundrymen's Association, May, 1911.

The Uses of High-Pressure Gas for Industrial Purposes.*

By E. W. Smith, M.Sc.

Gas furnaces may be divided into two types:—(1) Those in which low temperature soaking heats are required—such as some types of muffle work—in which it is a disadvantage to have a large supply of primary air; and (2) those in which high temperatures or large quantities of heat are required, such as in annealing or crucible furnaces, in which it is necessary to have the largest supply possible of primary air efficiently mixed with the gas before combustion.

Of the first type, it is sufficient to say that it is a simple thing with high-pressure gas, natural draft or air blast, to attain the requisite conditions with a high degree of efficiency in a properly-designed furnace, although with high-pressure gas more even results are possible. In the second class air blast and low-pressure gas and high-pressure gas have a much wider range of manipulation than natural draft.

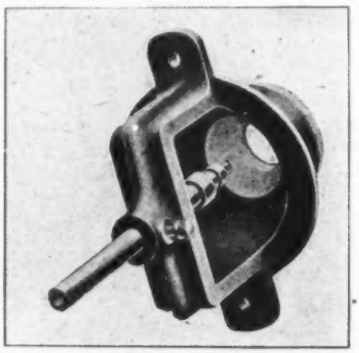


FIG. 1.—HIGH PRESSURE GAS BURNER.

The disadvantage of furnaces heated by low-pressure gas and air blast is that the efficiency depends on the two pressures remaining constant. Experience shows that, under working conditions, it is too much to expect that these will remain constant; but the main defect in air-blast burners up to quite recently has been that they were badly designed, their mixing arrangements being inadequate. Such burners as those recently designed, which do away with secondary air and improve the mixing of the air and gas, are a great advance on previous designs.

The Burner.

All high-pressure burners depend for their air on injection. An increase of gas pressure should inject a relatively larger amount of air through the burner. Where the gas injector plays into a tube, or expansion chamber as it is called, it was observed that an increase in gas pressure did not cause a corresponding relative increase in the volume of air injected. This was due to the increased expansion of the gas in the expansion tube owing to its expanding from a higher pressure. It was decided to do away with the expansion-chamber and play the jet into a correctly shaped and dimensioned conical hole, which should be part of the burner. The diameter of the narrowest part of the cone was determined for various consumptions; and to aid the flow of the gas and promote the best mixing the angle of the cone was found to be 60 degrees. The tube holding the jet was then made adjustable—moving towards or away from the cone—in order that the volume of air carried into the furnace could be regulated. Experiments show that much more than the theoretical quantity of air can be injected. The construction of the burner can be seen from Fig. 1.

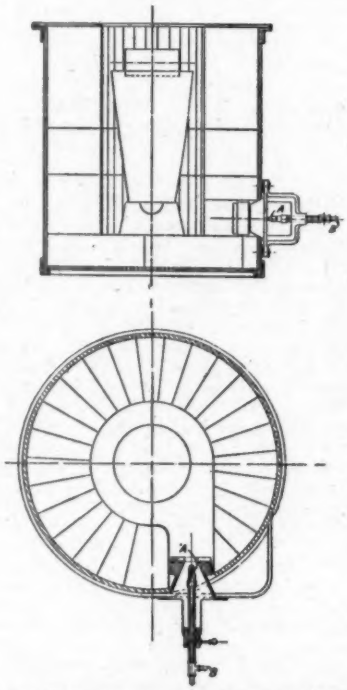


FIG. 2.—VERTICAL AND HORIZONTAL SECTIONS OF TYPICAL HIGH-PRESSURE GAS FURNACE.

It was next found that, although the efficiencies in furnace heating depended largely on the burner used, they also depended on the arrangement of the burners, on the cubic capacity and design of the combustion space, and on the nature of the refractory materials used. The amount of combustion space varies with the specific heat of the metal to be melted and the temperature to be attained. As an example, it may be noted that when brass is melted in a 60-lb. graphite crucible resting on a 3-in. stand in a cylindrical furnace the space between the top of the sides of the crucible and the sides of the furnace should not be more than three-quarters of an inch.

In no high-pressure furnace is there any appearance of flame, either at the burner or in the furnace itself, after the furnace has once been started. Combustion takes place over the sides of the furnace and the crucible—if a crucible is being used. The whole is

*Abstract of Paper read before the annual meeting of the Institution of Gas Engineers, June 13, 14 and 15, 1911.

highly incandescent, and the intervening space is quite clear. A typical high-pressure furnace containing a single burner may be seen in plan and in section in Fig. 2. The gas and air enter the furnace tangentially, and circle round the pot. The same principle holds good in other types of furnaces. The usual practice is to use one or more double-jet burners, in order that, when it is necessary to reduce the gas consumption in the furnace, one or more of the jets may be turned off instead of partially reducing the consumption from any of the jets.

The newer furnaces are being built with a double circular lining, consisting of the best standard-sized arch firebricks, in order that, when the inner one is no longer fit for use and past repair, it may be quickly replaced by another. The second lining outside the inner one acts as a base to which to build it. New furnaces are also supplied with false bottoms, simply held, which may drop out when relining or in case of a spill due to a broken pot.

Gas for Foundry Purposes.

In brass melting, the loss of zinc is only 75 per cent. of the loss in coke-heated furnaces. Loss by oxidation in the furnace in melting copper is altogether done away with, the atmosphere in the furnace being a reducing one. The number of heats to be obtained from the pots is increased; and in case of a spill into the furnace, there is less difficulty in dealing with the spilt metal than is the case when the metal falls among coke. Also, heats can be regulated to a nicety.

Gas crucible furnaces should preferably be run on the foundry system; there being one "melter" to attend to a number of furnaces—at least six—and "pourers" for casting. Muffles and ovens are specially adaptable to high-pressure gas heating when correctly designed. Tube-brazing furnaces, both for steel and brass, are entirely successful, evenness of results being again an advantage.

The cost of melting different metals and the time taken depends very largely on the state the metal is in, both as to cleanliness and bulk and the purposes for which it is required.

A view of the Windsor Street Foundry, Windsor Street Gasworks, Birmingham, is shown in Fig. 3. It consists of a large room 40 ft. by 20 ft., top and side lighted. There is an overhead traveller for unloading and moving large furnaces. Nine 16-ft. chimneys have been put in instead of one large one. The whole is lighted by means of high-pressure gas. There are more or less permanently installed in the foundry, three crucible furnaces—500-lb., 160-lb., and 60-lb. respectively—a twin muffle furnace, a tube-brazing furnace, blow-pipes, and a small furnace for expanding the ends of 5-in. steel tubes.

Compressors, Governors, and Fittings.

In areas where there are no high-pressure mains available consumers who apply for high-pressure gas are recommended to install suitable compressors of their own. Where there is available power to drive them from steam or gas-driven shafting, the outside cost for compression is not more than 2d. per 1,000 cubic feet—this figure including maintenance, power, and interest on capital outlay. For pressures higher than 6 lbs., the author is of the opinion that the rotary compressor is unsuitable. For pressures below this, certain makes of rotary compressors can be highly recommended. The reciprocator type of compressor had been found to give very good results for working pressures of 5 lbs. to the square inch upwards. It is also more positive in its action than the rotary, and requires a lower speed of revolution to run it. In this type, there is an increased number of parts, and, consequently, the machine might require more careful attention. Where the high-pressure main is available, the consumer is, of course, free of all such complications.

FIG. 3.—HIGH-PRESSURE GAS FOUNDRY, WINDSOR STREET GAS WORKS, BIRMINGHAM.

A governor is absolutely necessary where the main pressures are higher than the consumer requires, which would be the case nine times out of ten. There are two chief designs of governor on the market. (1) Those of the diaphragm type; and (2) float governors. For general work, the former seems to have been adopted as being the more satisfactory and reliable; while most of the designs of the latter type for pressures of 7 lbs. to the square inch and upwards are at present only in their experimental state.

In Birmingham, high-pressure services are of steam piping, this being heavier and less porous at the lateral joints than gas-piping. Owing to the bearing space on the threads being so small where taper threads are used in conjunction with parallel threads in the socket, it is found better—and, in fact, necessary—to employ parallel threads throughout. Most high-pressure gas-cocks have one defect in common. The way-through is almost invariably reduced from the full diameter of the pipe. The gas is consequently wire drawn, and the pressure at the outlet considerably reduced. Cocks should be full-way, made of gun metal, with as high

a bearing surface as possible, and have inverted plugs.

Where high-pressure gas is taken from the main, it is generally agreed that each consumer should have a governor placed before the inlet to his meter. He would then not only have a supply at constant pressure, but it to a great extent solves the mechanical difficulty of metering the gas. Some standard pressure should be adopted to which all volumetric measurements may be corrected back.

The High-Pressure Gas Blow-Pipe.

Early experiments showed that gas escaping from a jet at a sufficient and definite velocity gave a stiff and non-luminous flame similar to that obtained with an air-blast blow-pipe. If the pressure was reduced, the flame gradually became luminous, and if increased the flame would leave the jet and combustion cease. This pointed to the necessity for a constant pressure as well as the use of a pilot light.

Neither of these conditions appealed to the writer, and they were discarded. A blow-pipe to be of use should be efficient under a wide range of pressures, and a flame obtained by means of a pilot light is ill-formed and uneven. The problem was partially solved by connecting a supply of high-pressure gas to both the gas and air tubes of the usual air-blast blow-pipe. The gas supply connected to the fine jet of the pipe, ordinarily the air-blast pipe, escaped as high-pressure gas. That connected to the usual gas-tube became expanded by passing into a wide tube, escaping round the jet for all intents and purposes as low-pressure gas. It was found that by leaving this latter turned slightly on so that a small flame was obtained round the jet—when the high-pressure gas was turned on from the jet, this small flame acted as a concentric by-pass or pilot light, with none of the disadvantages of the orthodox form of pilot light. When the maximum stable flame had been obtained from the high-pressure jet, the low-pressure supply could be turned on and the size of the flame increased—it being non-luminous, partially luminous, or luminous depending on the velocity of the gas coming from the high-pressure jet.

It was found that all sizes and types of flame in all their graduations would keep alight at the blow-pipe if a metal tube was fitted round the burner jet. This tube not only kept the flame "in," but brought about such a good mixture of gas and injected air that the flame produced was found to be at least 100 per cent. hotter than a flame of the same gas consumption obtained from the usual type of air-blast blow-pipe.

Melting Aluminium and Its Alloys.

Although aluminium and its alloys are generally considered to be peculiarly suitable metals to be melted in gas furnaces, it is found, as the results of a long series of experiments, that, owing to its specific heat being high, the amount of heat necessary to melt it is more than for brass which has a higher melting point.

	Specific Heat.	Melting Point. °C.	Specific Gravity.
Aluminium	0·212	654·5	2·56
Brass	0·094	900·0	8·40

Owing to the low specific gravity of aluminium, a pot which will hold 500 lbs. of brass will only take 140 lbs. of aluminium; and assuming the temperature to be the same in both cases—it would be higher for brass—the heat losses per lb. of metal melted are greater in the case of aluminium than with brass. Aluminium is most efficiently and conveniently melted in large quantities, as the metal, when ready for pouring, may be ladled for casting in hot 20-lb. crucibles, which have previously been warmed.

The Birmingham Aluminium Castings Company, Limited, melt, on the average, 17 tons of aluminium alloys per week. Of this amount, 7 tons 10 cwts. are now being melted by means of high-pressure gas in furnaces and the remainder are being melted in coke-furnaces, but the Company are about to convert all their furnaces to high-pressure gas. The daily gas consumption now averages 19,000 cubic feet. High-pressure gas being installed, all blow-pipe work for warming the moulds and for other purposes has been transferred to high pressure. This has done away with the power for air blast, and with the cumbersome double-armoured tubing necessary. The Company have four furnaces, each consuming, on the average, 450 cubic feet an hour. The furnace has a loose bottom, and is heated by means of eight jets facing tangentially with the inner side of the furnace—four jets on either side. The cost of melting depends very largely on the state of trade and the nature of the castings to be poured. The smaller and finer the castings, the greater is the cost of melting, as not only has the metal to be allowed to soak in the furnace a little longer, but the whole of the casters are engaged in work which requires little metal.

The cost of melting in the new furnaces, week in and week out and including wastages, dinner hour losses—when furnaces are running at half heat and no metal is being poured—works out at 12s. a ton. On a single day's melt, under good conditions of working, this figure is halved. The average rate of melting is 100 lbs. in half an hour. The manager states that, by using high-pressure gas instead of coke, the labour costs are halved, the cost of melting is more than halved, the amount of metal melted per pot is much increased, and there is less oxidation of the metal during the melt, owing to the presence of a reducing atmosphere throughout the furnace. The method is much cleaner, there is no carting of ashes, there is no stoking up, heats are easily and simply controlled, and there is a more even alloy. As a result of careful tests it has been found that the tensile strength of the alloy is increased, there is a saving in the rebuilding of the linings when the inner one is worn out, and, lastly, the new method is much better for, and much preferred by, the furnace men.

The figures given here are actual works costs. In the Birmingham Gas Department high-pressure foundry, aluminium is being melted as low as 6s. a ton. With gas at from 1s. 3d. to 1s. 6d. per 1,000 cubic feet, there should be a great future for it for industrial use. It can be applied to all heating processes with efficiencies reaching in some cases at least 90 per cent. Its chief charm is its cleanliness and its simplicity; and in by far the majority of cases it compares well in cost with solid fuel.

Melting Ratios in Brass Foundries.

In the course of a discussion on the efficiency of furnaces, at the American Foundrymen's Convention, Mr. Webster stated that in using anthracite coal the ratio was from 2½ to 3 lb. of metal melted per pound of fuel. Mr. Corse stated that with coke, the average was 45 lb. of fuel to 100 lb. of metal. Mr. McKimmon stated that in a Steele-Harvey furnace he had melted 900,000 lb. of bronze for light castings at an average consumption of 3¾ gal. of oil per 100 lb. of metal. The metal charged was 1-9th borings, and the loss in melting and subsequent grinding was 4.6 per cent. The cost of the oil averaged 18 cents for 4½ gal. It was stated also in the discussion that the fuel consumption in a Charlier furnace averaged 3 gals. of oil per 100 lb. of metal.

Green-Sand Cores for Engine Beds.

By Percy Jones.

When a large number of engine beds are required urgently from the same pattern, time and expense must be saved by using green-sand cores, which, if properly made, will turn out castings just as perfect as dried cores, besides saving the overnight waiting for the drying. The pattern must be made so that the moulder can make his own cores in green sand from it.

An example of this work is the engine bed shown in Fig. 1. The upper surface is to be machined across the facings *a*, *a*, *a*, whereon the cylinder is to be seated, and in order to get sound metal on this sur-

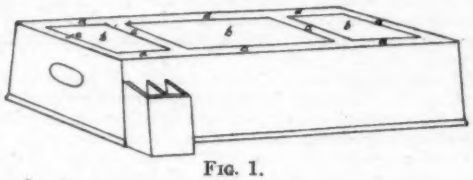


FIG. 1.

face it is necessary to make the mould with this surface on the under side, as shown in Fig. 2.

The following is the process of making the mould: Having got the required moulding box for the job, it is placed over a cinder bed. Two straight-edges are placed at the bottom of the mould, in order to get a level bed. This is well vented down to the cinder bed, after which these vents are made up and the level surface sieved over with facing sand. The pattern is then placed upon this, and is lined up with facing sand, and rammed on the outside to a depth of three inches, placing dry-sand runner cores (which have been specially made) and down (wooden) runner sticks at each side, for the purpose of gating the casting.

Having done this, the pattern is held firm, and it is best to ram the core to the same height, proceeding in this manner so that the wooden pattern is not rammed out of shape. Special core plates are required for the making and safe handling of these cores. The plate consists of a cast-iron base, with prongs cast on and two wrought-iron staples which are cast in. The

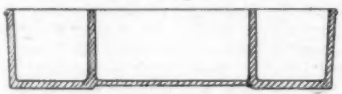


FIG. 2.

appearance of the plate is as in Fig. 3. These core plates must be bedded in, taking great care to have the bed underneath and about the prongs of the plate very firm. A joint has to be made around the edge of this plate, using wet parting sand, and must be kept good, in order to have the part around it perfect.

Ramming the cores may now be commenced. First, the lifting plates are clay-washed and a bit of good, strong sand rammed on to them, placing a row of 5-inch sprigs all the way round, using straight irons and lifters in the corners and along the sides for the purpose of strengthening the cores. The interior must be full of small cinders, for the purpose of venting and getting the air away.

Both cores and pattern alternately are rammed to the top, placing a loose washer, which has to form hand holes, at each end. A flat joint is made over the cores and pattern, sprinkling with dry parting sand. Next place on the top box, which is flat and about five inches deep, placing vent pipes and riser pegs in position. After ramming up this box, it is lifted off, placed on tressels and finished. All the way round the box edge is vented, and all is now ready to draw out the cores. Small clams are placed on the hooks of the chains, and linked to the staples of the cores, and the cores withdrawn very gently, shaking the chains gently so as to have a good draw. Empty blacking tubs, having a flat plate temporarily placed on them, are used for the purpose of standing the cores on while they are being mended up. Afterwards the cores are blacked with dry plumbago, using a flat camel-hair brush for the purpose. Having done this, the joint of the pattern is slaked with water and withdrawn. It is then finished, and the loose washers (hand holes) withdrawn also, but before being blacked the maker's name has to be impressed in the sand on the side of

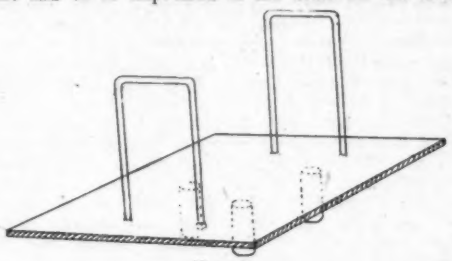


FIG. 3.

the mould. This is done by using a flat board made for the purpose, having the maker's name standing out in relief on the board in lead letters.

The mould is then blacked, using plumbago and brush as before; the tank cores, which are of dry sand, are placed in their prints, being held down by two pipe nails in the top box, placing a double-headed stud in between them. The hand hole cores, which are also dry sand, are held in position by boring two holes through each, using two 5-inch sprigs for each. Then comes the job of placing the three green-sand cores in their places. First see that the prongs on the core plates (underneath) are clean, and the same with the holes made to receive them in the mould. They are then lifted by the crane and gently lowered into their berths, the end one first, and are steadied by placing the hands on the top as they are being lowered. When all the three cores are in place, a small quantity of whiting is put around each, to see if they touch the top part of the box, and the wooden down runner sticks drawn up. Having ascertained that the cores touch, the top is finally placed on, the runners, risers, and vents made up, the box weighted, and the mould is ready to cast with good fluid metal.

At the recent American Foundrymen's Convention, Mr. Corse, in replying to a question of the effect of rapid cooling on manganese bronze, said some people believed a difference of 50 per cent. in strength existed between chill and sand castings, which was erroneous. The tensile strength of a chill casting might be 80,000 lb. per sq. in., as against 75,000 lb. from the same alloy cast in sand.

Coke and the Foundry.

By Richard Moldenke.

(*Continued from page* 343.)

Burned Iron and Its Effect in Castings.

The burning of iron in the cupola process, and in fact every melting process to a greater or less extent, is now becoming better understood. In years gone by no one could be made to believe that such a thing was possible. But anyone having to do with making the iron silicates can realise how very little silica can carry great quantities of iron to make a thin black slag. In the bottom of the open-hearth furnace pools of iron often remain after the heat is drained out. These pools oxidize rapidly, burning away with a fine display of sparks, the oxidized material uniting with the sand bottom and making a temporarily dark spot. This action is observed especially in the malleable process with the open-hearth furnace. In the Bessemer process the burning of iron is so obvious that one has only to stand near the blow to be spattered with pellets rich in iron. In making pig-iron one has only to note that the same size of furnace that makes a given quantity of good, "honest" pig-iron for the foundryman is made to yield very much more pig-iron when forced. Iron made thus must be oxidized slightly and produces castings weaker than they ought to be. Even in the cupola the scintillations can be seen as the drops of metal find their way to the bottom. The exact degree to which the oxidation thus brought about affects the product depends on the rapidity of the stream downward, the condition of the blast as regards unconsumed oxygen at the point where the iron is melted, and the consequent condition of the metal itself. If the metal is oxidized even slightly, its melting point is raised, and it will drop more sluggishly and receive more damage from the blast further down. Hence the importance of nicely balancing melting conditions by proper attention to the coke and charging.

In the coke-melting tests at St. Louis another matter carefully watched was the quality of the metal cast. In every test that showed high melting loss the castings were observed to be full of pin holes near the surface, and in some tests the metal was like a big sponge. Though the silicon necessarily ran low with repeated remelting, enough remained to keep the body of the metal gray; but whenever the iron was burned the fins on all the castings were white.

Long experience in the foundry business has taught the writer that whatever cause may be put forward for such defects in castings as pin holes, excessive shrinkage, draws, and cracks, and for others due to the metal and not to the moulding, practically all of them can be traced back to burned iron. Whenever steps have been taken to correct the cupola practice, these troubles have disappeared. Pin holes are due, not to the inability of the air to get out of the moulds fast enough, but to the yielding up of dissolved gases in the iron at the moment of set. The first thing that happens in the mould, if the iron poured is not much overheated, is the setting of a thin skin of metal against the sand, and hence these gases in going upward and outward to escape strike the thin shell that has set and stay there. When the casting is put on the planer and the skin is removed the pin holes make their appearance and the casting is condemned. Such an outcome is particularly annoying with respect to fine varieties of rolls, on which an unblemished surface is absolutely necessary. When the metal is badly burned, as, for instance, in low-silicon heats for malleable castings, the formation of gas is so strong that the casting is honeycombed, not with pin holes as in the high-silicon iron, but with blowholes half an inch across, and the interior surface is black from oxidation.

As a further difficulty, if the metal is oxidized even very slightly its melting point is raised considerably, so that it readily freezes or, as the foundryman has it, loses its "life," and the ladles "skull." As a consequence, in pouring the gates freeze up and the castings are short poured. If the casting has been poured, the molten metal may be cut off so quickly that interior shrinkages are more than likely to occur, as no feeding can take place.

Finally, burned metal is very weak. It seems as if a coating of oxide gets between the several crystals, so that their tenacious grip on one another is lessened. Hence casting strains find the metal unprepared to resist and a crack is the result. A little oxygen can do an immense amount of damage. The very worst burned iron ever seen by the writer contained only a few hundredths of 1 per cent. The evils of high sulphur are as nothing compared to it. Hence only a very small amount of aluminium or titanium is necessary to make the correction, more than 0.1 per cent. seldom being required for addition to the ladle to produce the desired deoxidation. All the facts outlined above show how important the subject is and why the ferro alloys are becoming such a factor in casting practice. However, prevention of this burning or oxidation is better than its correction afterwards by means of alloys of iron with titanium, aluminium, manganese, and silicon.

Cupola Charging and Its Relation to Quality of Metal.

All melting occurs above the tuyeres, for the blast can find an exit only up the stack. The coke below the tuyeres is therefore only a filling and serves no other purpose, as it is not even so hot as the molten iron that collects around it before being tapped. The tuyeres are placed high or low, as the exigencies of the shop may require. Where a continual stream of very hot metal is wanted, as, for instance, in light casting work or in the moulding of stove plate, the tuyeres are placed about 6 inches from the bottom and the coke filling is least in volume and height. For melting pig-iron before it is Bessemerized for steel the tuyeres may be a few feet above the bottom, because a rather large tonnage of metal has to be kept between blows. In European practice the forehearth does the work of a deep crucible in the cupola, serving as a big ladle or catch-basin for the molten metal running unchecked out of the cupola spout. The forehearth, however, is intended to be heated as part of the blast arrangement; but unless the regenerative system is used it is doubtful whether high enough temperatures are obtained to do this heating to any considerable extent. The proper method would be to use a mixing furnace, such as may be seen in steel practice. This is merely a tilting open-hearth furnace, in which the metal is kept continually up to the proper temperature.

Between the least and greatest depth of the bed below the tuyeres there are, of course, depths adapted to various classes of work, some foundries preferring a height of 20 inches between the bottom and the tuyeres and others 14 inches, 10 inches, or whatever height gives them the space they want for the storage of metal. The

quantity of coke thus used, especially in small heats, naturally affects the melting ratio; if this fact is forgotten and a high ratio is arbitrarily selected, the heavy bed often leaves too little coke for the upper charges. In long heats this factor is not so apparent.

Small Charges.

The portion of the bed above the tuyeres is next to be considered. Here the actual work of melting is done. The cold air entering the cupola at once attacks the coke and delivers up its oxygen, which, by the time it is all consumed, has traversed a certain distance inward and upward. This distance probably limits the melting zone, the shape of which no one can tell until experiments such as were referred to above have been made. The effect of this zone is seen along the lining, and the more defined and the narrower it is the better are the results. If the zone, as shown by the cutting action on the lining, spreads over a considerable height, the melting is irregular. The lining should be fairly clean throughout, easily chipped out, and quickly daubed up. Otherwise practice has been defective.

This melting zone may be in the shape of a parabola flaring upward along the sides or, if Mr. West's centre blast is used so that the blast pressure is more nearly equally distributed, its upper limit may approach a flat plane; in either case the highest temperature is reached at a point somewhat above the entry of the air, and above that point the heat diminishes. It is in the melting zone that the reaction between the oxygen of the blast and the carbon of the coke bed is most intense, and it is here, probably, that the formation of carbon dioxide is greatest. Here, too, the cupola temperatures reach a maximum, probably about 3,500 degrees F. Below the narrow limits of the melting zone the temperatures are less because the combustion of the carbon, its reaction with oxygen to form carbon dioxide, is incomplete. Above the melting zone the temperature falls because, if the coke bed is thick enough, the carbon dioxide formed in the melting zone has to pass through incandescent fuel, and the glowing carbon reacts with the carbon dioxide to form carbon monoxide, the gas that may be seen burning in the upper part of the cupola. This reaction takes up heat, and hence within a distance of 3 ft., if the coke bed is so thick, the temperature falls to about 2,100 degrees F.

It is evident that if the thickness of the coke bed is so proportioned that all melting takes place within the melting zone, the melting will be done quickly and well, for the melting point of the iron ranges between 1,900 degrees and 2,400 degrees F. If, however, the coke bed is excessively high, some iron will begin to melt as soon as the coke bed had burned away enough to bring the temperature above the melting point, and will melt slowly. As a result, cold metal will drop into the crucible of the cupola, causing the many annoyances of cold metal in pouring. The best economy is naturally had if the metal is just at that point of highest temperature, and not much below or above it. As the heat progresses the coke is rapidly burned away. Hence the bed is lowered and the metal sinks; the next charge of coke is intended to restore the bed to its original height so that each successive charge of metal may melt in the same position in the cupola. Under the best conditions the lower part of the metal charge melts in the upper part of the melting zone, and the upper part of the metal charge melts in the lower part of the melting zone. Hence if a metal charge is too heavy some of the iron is melted below the normal limits of the melting zone, and if a charge is unnecessarily light all the iron is melted in the upper part of the melting zone. If each charge melted at the same level there would be no more to say on the subject; and the fact that it did happen in former times, when no attempt was made to charge in layers, shows that perhaps we have not progressed so much as we suppose.

If, as there is reason to believe, the melting is best done at the point of highest temperature, the point at which the last portion of the usual heavy first metal charge must melt, owing to the sinking of the bed and the metal, is considerably too low in the cupola. The heat may be high enough there, but the gases in the cupola near the tuyeres are not yet free from uncombined oxygen. As a result the metal must suffer somewhat by contact with this free oxygen at so high a temperature. If this statement of conditions is in any degree true, the remedy is to make the charges as small as possible, so that the fluctuation in position of the effective part of the coke bed may be as slight as possible, and the cutting action in the cupola limited to a height of a few inches instead of feet.

Uniform Charges.

Inasmuch as only the very top of the coke bed is effective for proper non-oxidising melting if it was made right at first, the question arises why it is the prevailing practice to make the first lot of metal several times as heavy as those succeeding. The obvious reason is plausible enough at first glance—namely, that a lot of metal ought to go on top of a lot of coke in the bed. It is forgotten how little of that big bed of coke really does the work of melting.

The damage caused by the big first charge of iron may best be shown by figures. Let us assume that every 1,000 lbs. of iron in melting uses up 1 in. of the coke bed. If the first big charge of metal is 6,000 lbs., 6 in. of the coke will have been burned away when the metal is melted. If iron is really damaged by oxidation, the last 3,000 lbs. of that charge is not quite so good as the first 3,000. Now, the first intermediate charge of coke comes down. Does that restore the 6in. of the bed? By no means. It is merely enough to melt the next and much smaller charge of metal. Let us say it restores the bed 3 in. and disposes of a succeeding charge of 3,000 lbs. of metal. The bed, restored only halfway up to its original position in the melting zone, burns down 3 in. again in melting the second charge, nearly all of that iron being melted at a point where it is affected by unconsumed oxygen in the blast. This restoration and melting is repeated until the end of the heat, and the practical effect of the big first charge is to give an inferior grade of iron for the entire heat, unless extra coke between the charges brings the bed up to the proper level.

Many foundrymen have recognised this point, and now run their cupolas with charges of metal alike from first to last; and the writer has persistently advocated this method as the first step in solving the problem of using all kinds of foundry coke successfully.

But if there is any advantage in keeping the fluctuations of the bed uniform, there is additional benefit in making this fluctuation as small as possible; hence the writer's second recommendation is to make the charges so small that the layers of coke are only thick enough to cover the layers of metal, unless definite knowledge regarding the range of the melting zone of a cupola permits heavier charges.

Adjustment of bed.

Another very important point remains for discussion. The bed must be of the right height to start the melting properly. Practically the only way to know when this height is right is to observe the time between "blast on" and "first iron." Every foundryman knows that when this time is about seven to ten, preferably eight, minutes he gets his best results. So in determining the right height of bed, if iron

comes at a time within these limits it is safe to continue to charge as in that heat. If the iron comes, say, in fifteen minutes, the bed is too thick; if it comes in four or five minutes, the bed is too thin. Thus this matter can be attended to at first. In a new cupola the bed can purposely be made too thick in the first heat and reduced subsequently until the proper time of "first iron" is reached. This "first iron" means the first metal running continuously just previous to "stopping up," and not the few random drops that often come in five minutes. Where in practice the tap hole is closed when the blast is put on, it had better be left open for a few days, until the action of the cupola in this respect is known.

In making the estimate of the correct time from "blast on" to "first iron," it was assumed that the charging was done on a fuel bed well burned through, with all the wood consumed. The writer has noted instances in which about a third of the bed coke was put on and burned through. Then the remaining two-thirds was added, the cupola charged, and the blast turned on. In such instances the first few minutes of the observed time to "first iron" were taken up by the fuel bed burning through and did not form any part of the melting time. Iron in eight minutes was really iron in four or five minutes, consequently the results were disappointing.

Too heavy a bed has nearly as bad an effect as one too thin. The thin bed, as has already been explained, has just the same effect as a very heavy first charge. The entire process of melting throughout the heat takes place too low down and in a more or less oxidising atmosphere. If the intermediate charges of coke used were not as a rule slightly heavier than necessary, thus causing the fuel bed gradually to rise, a low bed together with a heavy first charge of metal would give serious trouble throughout the heat. As it is, these conditions may account for much of the badness of the "first iron," commonly laid altogether to sulphur.

On the other hand, too thick a bed unduly delays the metal. The bed has to burn away, and while it burns some of the stock melts slowly too high in the cupola and hence is exposed too long to the influence of the cupola gases. The melting is therefore slow, and the iron may be slightly burned and is apt to be cold. Slow iron nearly always means inferior iron. The evils of too heavy initial charges are perhaps most noticeable in air-furnace and open-hearth practice, where a slow heat is an abomination.

If the bed is too thick, a heavy first charge of metal keeps the succeeding charges of iron from melting too high in the cupola and reduces the danger from burned iron. The writer, indeed, has observed a number of instances of excellent results obtained, with a thick bed and heavy first charge, with very small intermediate charges. Such practice does not seem good, however, as some of the "first iron" will be dull. Better have a proper bed and uniform charges.

In changing from the current practice of high fuel bed and heavy initial charge of metal, it will be noticed that a little while after the start the melting always becomes slower; that is, of course, if the same ratio of coke to iron is used for the intermediate charges in the two methods. This is because some of the coke which was used up under the old conditions to make slag and cut the lining becomes available for melting, less fuel is needed, and the fuel bed rises. This thickening of the fuel bed and slow melting is easily remedied, when observed, without doing harm anywhere and with a saving of coke by changing the melting ratio; that is, cutting down the intermediate coke charges slightly.

It does not follow that burned iron always results from very heavy charges. When the conditions become such that the molten iron is attacked by oxygen, the iron may be protected by the manganese in the charge. Silicon gives similar but less protection. The foundryman merely has to remember that when the metal is slightly too low in the melting zone of the cupola the same conditions obtain, though in far smaller degree, as in the Bessemer process, in which manganese, silicon, and carbon, and with them more or less iron, are burned out. What the foundryman should look to is that his cupola does not become a sort of converter during any part of the melt.

In conclusion, it may be said that the logical method of cupola charging after the bed is in would be to do away altogether with separate metal and coke charges, and yet keep the proper ratio of iron to coke in separate piles on the platform and charging a small quantity at a time from each pile, after the manner of proportioning sand and facing materials. The claim has been made that this method, the one used by our foundrymen forefathers, means slower melting, but careful trial has shown that such is not the case. However, the discomfort and cost of the method will preclude its use.

Standard Test Bar for Cast Iron.

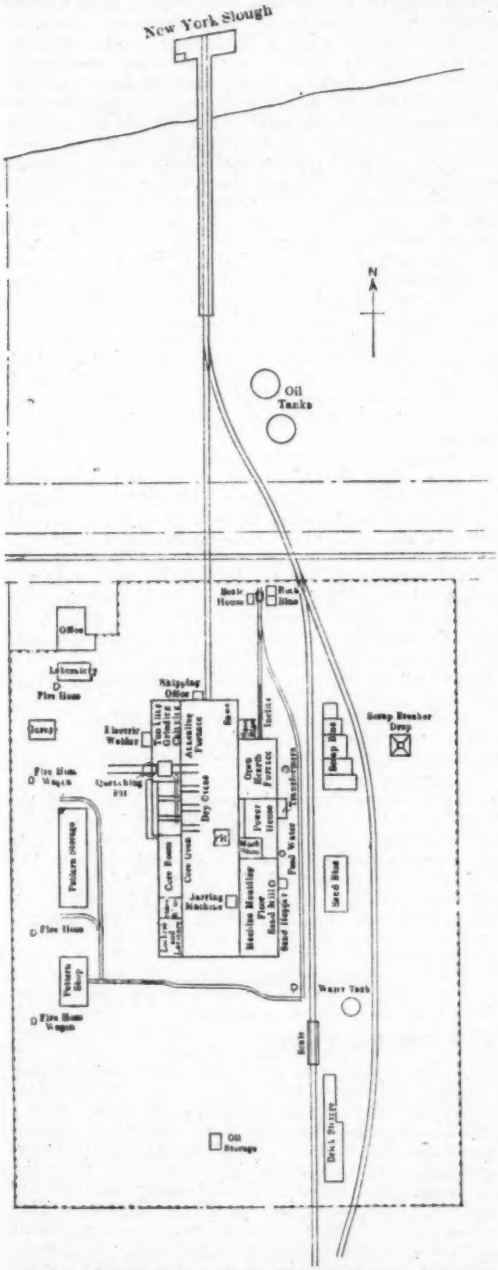
At the Pittsburg Convention of the American Foundrymen, Dr. R. Moldenke presented a "Memorandum on Standard Test Bars for Cast Iron," in which he called attention to the discussion of the arbitration test bar at the Copenhagen Congress of the International Society for Testing Materials. This test bar is 1¼ inches in diameter and 14 inches long, and is broken transversely on supports 12 inches apart. The comparison of practice showed that, so far as the diameter of the bar is concerned, foundrymen and users of castings generally agree that as large a bar as can conveniently be handled on ordinary testing machines is the one to adopt. Germany, Italy and the United States have adopted the 1¼-inch bar and while England is favourably inclined, no official action has yet been taken on the subject. Opinion as to the casting test bars on end in dry sand appears to be unanimous although in Germany these bars are cast from the bottom. The radical difference in the several standards seems to lie entirely in the length of the bar. In the United States, the bar is 12 inches between supports, in Germany almost 2 feet long, while in Italy the length between supports is only 6 inches. It was, therefore, suggested at the Copenhagen Congress that a series of tests be made in the several countries interested, with bars ranging from 6 to 24 inches between supports and from the results obtained, the length be selected which will give the best general values.

Three series of tests were made on an average of nine bars each and the modulus of rupture of the bars tested on a 12-inch span was 45,930 pounds per square inch, 18-inch span 44,570 pounds per square inch, and 24-inch span, 42,800 pounds per square inch. This indicates a steady downward progression of the modulus of rupture for cast iron, as the span increases.

Ten sets of four bars, 1¼ inches in diameter and 26 inches long, were also cast and these were broken on supports 14, 16, 18 and 20 inches apart. The composition of the metal was:—Silicon, 1.90 per cent; sulphur, 0.08 per cent; phosphorus, 0.75 per cent; manganese, 0.65 per cent; combined carbon, 0.55 per cent; graphitic carbon, 3.10 per cent., and total carbon, 3.65 per cent. The molulus of rupture of the 14-inch bar was 44,000 pounds per square inch; 16-inch bar, 43,800 pounds per square inch; 18-inch bar, 43,800 pounds per square inch and the 20-inch bar, 44,100 pounds per square inch.

A Californian Steel Foundry.*

In the Eastern section of America the starting up of one more steel foundry is not a very important event. On the Pacific Coast, however, quite the reverse is the case. Recently the Columbia Steel Company, with the main office at 503, Market Street, San Francisco, California, which heretofore has been operating a converter plant at Portland, Ore., started its new basic open hearth plant at Black Diamond, California, a small town at the head of San Francisco Bay. The equipment of the foundry and its arrangement are thoroughly modern, as is shown in the partial plan reproduced herewith. The property owned by the company comprises twenty acres, having a water frontage of 800 ft., and railroad connections with the Southern Pacific and the Santa Fé systems.



PLAN SHOWING LOCATION OF BUILDINGS AND TRACKS AT THE FOUNDRY OF THE COLUMBIA STEEL COMPANY.

* Abstracted from an article in the "Iron Age."

The Buildings.

The main foundry is a steel structure throughout, 130 ft. wide by 260 ft. long, with a craneway extending through the end of the building, permitting the transfer of flasks, castings, etc., with the least possible amount of handling. The walls of this building are largely composed of glass.

The pattern shop is a brick building, 30 by 50 ft., with trussed roof and lighted on all four sides with spacious windows. Next to this is the pattern storage building, a two-story brick structure, 30 ft. wide by 100 ft. long, which is arranged with a system of shelving for storing patterns so that any desired one may be located readily by simply referring to the pattern index.

The laboratory is another brick building which is sub-divided into a chemical department, a weighing department, and a testing machine department. This is a well arranged laboratory, and in it minute records are kept of the chemical and physical properties of the steel turned out in each heat. The office building is located close by, and is subdivided into a general office and separate rooms for the officials and various departments.

General Plant Equipment.

A dock is built about the middle of the water front, and standard gauge tracks run from the yards to this dock for the transfer of material coming or going by water. A pipe line extends from this dock to the oil tanks, as the fuel used throughout the plant is oil, and the most economical way of handling it is by pumping it from the oil vessel to the large storage tanks located near the water front. A line running from these tanks to the power house supplies the pumps furnishing the burners of the boiler, open hearth furnaces, ovens, etc., with fuel.

A modern locomotive crane of 10 tons capacity serves the yard for transferring cars, loading castings and unloading pig-iron, scrap and other raw material by a powerful magnet. This crane is also fitted with a grab bucket for unloading cars of sand, limestone, fluorspar and other supplies.

For fire protection this plant is well equipped. A large underwriters' pump, located in the power-house, pumps direct from the river through 6-in. mains surrounding the entire plant. In addition to this a reserve tank, containing 50,000 gallons of water, is located close to the main building on a steel tower 70 ft. high.

The Foundry.

The equipment of the foundry proper is all quite modern. The bay is 60 ft. wide and a 30-ton crane, as well as two 10-ton auxiliaries, travel its entire

length and out into the yard. The whole arrangement of the shop is such that the moulding is done at one end, and when the moulds are made they are carried to the drying ovens. After drying they are immediately placed in front of the open hearth furnace, where they are poured. As soon as the castings are broken out of the moulds, they continue on their way to the cleaning department. After being cleaned they go to the shipping department and out of the building to rail or boat, as the case may be.

The furnace is of the open-hearth basic type, and although nominally rated at 15 tons, is capable of melting 25 tons at a single heat. It is served by a high frame charging machine, running the full length of the charging floor, which is built entirely of 12-in. channels, riveted together with the flanges resting on the I beams of the floor construction, while the web forms a smooth floor. Immediately in front of the charging doors the steel is bricked over to give a firm footing for the melters when shovelling or rabbling.

The moulding floor occupies the southern half of the building; next is the drying oven department and the pouring floor, and finally the chipping department, where the castings are prepared for shipment. Jib cranes, swinging from every other column throughout the length of the shop, as well as the travelling cranes, serve the shop so efficiently that delays in handling are reduced to a minimum. Modern pneumatic moulding machines and core machines complete the floor equipment.

The annealing department is arranged not only for handling mild steel castings but also manganese steel with a special peel machine, which takes the castings out of the annealing furnace and transfers them while hot to the tempering department for subsequent treatment.

The cleaning department is equipped with direct connected electrically-driven grinders, swing grinders, cold saws and draw shapers. There is also a sand-blast room set apart from the main cleaning department with a car running into it from the main shop, so as to reduce handling to a minimum Electricity is used as power for driving the numerous cranes and tools.

Titanium in Iron.*

By C. V. Slocum.

Mr. A. W. Whitney, metallurgist of the Enterprise Foundry and Machine Company, Bristol, Va., has made a number of careful trials of titanium in hard or chilling iron. He found that 0.1 to 0.2 per cent. of the alloy is usually all that is necessary to make otherwise viscous, high-chilling mixtures come from the cupola close-grained, and pour from the ladle as freely as iron carrying half as much chill and of more open grade. The iron pours well to the last and gives clean, solid castings. Mr. Whitney says he is able to compensate for the cost of the titanium with less manganese and a trifle less silicon.

The fact that the metal remains hot longer than untreated iron is a matter of much importance for certain classes of work, since the greater fluidity means that the iron will settle more slowly in the mould, and thus give time for the gases to escape and more time for the iron to fill every small outline of the mould without pulling away from the main body of the casting.

The writer maintains that a great deal of undue importance is often attributed to an increase in transverse and tensile strength. This may be necessary for castings which must resist unusual stresses in service, and for such it is necessary to use at least 1 per cent. of titanium alloy. However, such a percentage is not only a serious increase in cost per ton of product for ordinary castings, but in all the practical uses to which most castings are subjected no special increase of strength is required, although an improvement in quality may be absolutely necessary. The writer has in mind a recent case where the castings in a certain foundry were stronger than necessary, were well made and were satisfactory; but when the small quantity of alloy usually recommended for such cases was tried, merely for the purpose of improving the fluidity of the molten metal and the density, machining quality and durability of the casting, the machine shop of one of the great railroad companies which turned up the castings reported that these treated specimens (piston rings) were closer grained, were more like steel and were more desirable for their purpose. Yet of the four test bars cast one of untreated iron was strongest in transverse strength.

On the other hand, a large manufacturer, having a 10-ton casting to make, and being anxious to have no failure in so important a job, added 1 per cent. of titanium alloy and secured a splendid casting which may have cost him £5 extra for all the alloy used, but which made a sure thing of a single machine-part worth at least £80, even without including the machining.

In a recent trial of titanium alloy in the cupola with a mixture of burnt iron, stove plate, etc., in a large foundry in the Pittsburg district, the rather large percentage (for iron) of one-half of 1 per cent. of alloy was used, together with one-half of 1 per cent. of ferro-manganese of the usual 80 per cent. grade. This trial demonstrated the interesting fact that the poorest mix may be brought to good normal iron by this method. The average of all the test bars, of which there were 10, was 3,100 lbs. breaking strain and an average deflection of 0.146 in.

One of the best known foundries in Columbus, Ohio, uses, for certain purposes, a cheap mixture which anaylses about as follows:—Silicon, 1.60 per cent.; sulphur, 0.11 per cent.; phosphorus, 0.55 per cent.; manganese, 0.50 per cent. One-fourth of 1 per cent. of titanium alloy was added in the cupola and the foundry foreman reported immediate benefit in the fluidity of the metal and in the distinct improvement to the castings. This rejuvenation of the iron, so to speak, was more than repaid in the reduction in bad work, without regard to the benefit to the iron. Castings from this iron, with fine grain and good metal, were made which were only 5-16th in. by ¼ in. section.

* Abstract of a Paper read before the American Foundrymen's Convention, May, 1911.

A New Aluminium Alloy.

An aluminium alloy recently patented in this country is claimed to have an unusual resistance to corrosion. The composition is:—Aluminium, 92 per cent.; copper, 5 per cent.; bismuth, 2 per cent.; and silicon, 1 per cent. The silicon is introduced as silicon copper, and the aluminium is added to the mixture after the other metals have melted. Another alloy also patented substitutes magnesium for the silicon, the composition of this alloy being:—Aluminium, 91 per cent.; copper, 5 per cent.; bismuth, 2 per cent.; and magnesium, 2 per cent. As in the case of the former mixture, the aluminium is added after the other metals have melted.

The Use of the Lifting Magnet in Foundries.*

By H. F. Stratton.

There appear to be three huge businesses which can profitably use lifting magnets for the transporting of iron and steel products; first, the steel industry, second, the railroads, and third, the foundry. Of these three industries in which the lifting magnet can apparently be used to economic advantage, the foundry has been by far the most reluctant to embrace or even to investigate the economies open to it.

The author desires to place before the foundry manager such figures that he will be enabled to determine what would be his cost of handling by means of a magnet, and assuming that he knows his present cost of handling by hand labour, to enable him to determine, by his own investigation, if the installation of a magnet equipment would be profitable in his individual case.

Cost of Installation and Operation.

A magnet thoroughly capable of withstanding hard abuse costs about $1,300 per ton of lifting capacity of pig-iron. Standard magnets are constructed in about four different sizes, and although this figure just named does not hold accurately for all sizes, yet it is a fairly close index to the selling price and is sufficiently accurate for purpose of estimate. It may be mentioned at this point that the approximate lifting capacities of these different sizes of magnets in service are, expressed in pounds of pig-iron per lift, as follows:—800, 1,350, 1,950. and 2,400.

Of course, some kind of a crane is necessary for handling a magnet, and if the foundry already has its yard equipped with either an overhead travelling crane or a locomotive crane, the installation of the lifting magnet becomes a simple and relatively inexpensive matter. If it be applied to an overhead crane, it is merely necessary to run leads from the crane to the magnet and to provide some simple mechanism for taking up the slack in these leads as the magnet is hoisted. If the magnet be applied to a locomotive crane, current can be furnished to the magnet either by suitable plug stations installed at various points in the yard, or an engine generator set can be put on the crane, the generator delivering current to the magnet and the engine taking steam from the boiler of the locomotive crane. This latter arrangement, while more expensive in first cost, is preferable in that it provides a flexible unit which is operative at any place which the locomotive crane can reach. A high-grade, four-wheel, 10-ton locomotive crane, complete with an engine generator outfit, can be installed at an expense of about $5,500, and such a crane will handle a magnet at a boom radius of about 40 ft., thereby covering a large area even if the crane runs on only one track. Of course, by the use of parallel spurs a large area can be conveniently, cheaply and completely served by the locomotive crane. A locomotive crane is of such general use to a foundry that it is only fair to charge but a portion of its costs to the magnet. If we consider that $3,000 is a proper proportion of the locomotive crane cost to charge against the magnet, and if a magnet is selected of such size that it will have a lifting capacity of about 1,350 lbs. of pig-iron, the cost of the magnet installation then becomes about $3,900, or, in round figures, $4,000, installed and ready to operate.

The operating cost of a magnet consists of certain charges, including operator's wages, fuel and oil, which will exist only when the magnet is in operation, and depreciation charges on the equipment, which will not depart much annually from a fixed amount, whether the tonnage be sufficient to keep the equipment busy practically all the time or only an hour or two a day.

A concrete case will be selected for the double purpose of indicating how similar estimates may be made to cover any particular foundry, and for pointing out a daily tonnage at which the installation of the magnet and crane appears to be an economic necessity. The assumption will be made that a foundry melts 35 tons of metal daily, 300 days in the year. All of this metal must, of course, be handled twice, that is, it must be unloaded from the car to piles and loaded from the piles to some kind of a wagon, on which it is carried to the cupola platform. For a foundry of this capacity the following figures apply:—

CHARGES PER HOUR.

	Dols.
Operator's wages	0.30
Fuel (at 3 dols. per ton and using ¼ ton per 10 hours)	0.15
Oil, etc.	0.03
Total	0.48

Economies Effected by Magnet.

A crane and a magnet of the size previously referred to, will conservatively handle 35 tons per hour, which will make a cost of 1.4 cents per ton. The annual depreciation on the $4,000 equipment at 12 per cent. would be $480, and as 35 tons handled twice per day for 300 days represents 21,000 tons handled annually, the depreciation cost on this tonnage basis is 2.3 cents per ton. This brings the total cost of handling, including wages, fuel, oil and depreciation, up to 3.7 cents per ton. I have been informed that 10 cents per ton is a fair figure to assume for the cost of loading or unloading pig by hand, and on this basis the saving would be $1,323 annually, or 33 per cent. on an investment of $4.000.

If the case of a larger foundry be cited, melting 100 tons per day for 300 days per year, and assuming in this case that metal is handled more cheaply at 9 cents per ton, by hand labour, the annual saving effected by the use of the magnet is $4,080, or over 100 per cent. on the investment. It may be mentioned in the case of the smaller foundry that the time the magnet is in use daily would be about two hours, and in the case of the larger foundry, with the magnet selected, about six hours daily would be required. In this latter instance it would doubtless be more economical to install a magnet having a lifting capacity of about 1,950 lbs., instead of 1,350 lbs., which was the basis on which the estimates were made.

With these figures in mind, attention is directed to this conclusion:—A foundry melting 35 tons of metal daily can install both a crane and a magnet, and expect a return upon the investment, after allowing all charges, of more than 30 per cent. If it happens that a foundry is already equipped with either an electric or locomotive crane, a magnet can then be installed on a very profitable basis when the tonnage to be handled is considerably less. For instance, if

* Abstract of Paper presented at the Pittsburg Convention of the American Foundrymen's Association, May, 1911.

an assumption be made that a foundry melts 20 tons daily, and that a magnet be installed on an existing crane, the cost of the magnet being about $900, then the cost of handling per ton, including wages, fuel, oil and depreciation on the magnet, is about 2.3 cents, which would represent a saving in this foundry of about $924 each year, or over 100 per cent. on the investment.

Other Advantages.

Exclusive of the economies already cited, certain other incidental advantages attend the use of a magnet. These, somewhat in the order of their importance, may be mentioned as follows:—

(1) The elimination of labour trouble.

(2) The ability of the lifting magnet to handle a drop ball for the breaking of castings too large to charge into the cupola. For this application the magnet not only serves to lift and accurately release the ball, but also to pick up and transport the broken pieces of the casting.

(3) The ability of a magnet to unload castings too heavy to handle by hand, and often of such shape as to be very inconveniently handled even by a crane with chains.

(4) The ability to stock pig and scrap in piles higher than would be possible were hand labour employed, and thereby make more efficient use of the available space in the foundry yard.

(5) The ability to unload cars more quickly, and thereby save demurrage.

(6) The recovery of small pieces of iron in the bottom of freight cars, which can be magnetically swept up, but which would be neglected if the cars were unloaded by hand.

(7) The convenient recovery of nails and iron shot in foundry sand. This is accomplished by slowly passing the magnet above the sand and as close to the sand as possible.

(8) Independence of weather; the magnet, if anything, lifts more on a cold day than on a hot one, and will lift pig when covered by snow.

A Sand-Papering Disc.

By Chas. A. Otto.

The drawings Figs. 1 and 2 show a simple method of using the back screw on a lathe for a sand-papering disc. In many pattern shops connected with small foundries or engineering shops, there is a scarcity of machinery, for the simple reason that there is not sufficient work to justify the expense of much being installed; but there are not many pattern shops where a lathe is not absolutely essential, and the majority of lathes in small shops have a turning. The initial outlay for the sand-papering machine is thus considerably lessened, the total cost being very small compared with the usefulness of such a machine. The castings required include table A, rest B and rest holder C if not previously attached to the lathe. The table A is 16 inches long, 11 inches wide, and $\frac{5}{8}$ of an inch in thickness, machined on the face and the bevelled edge next to the disc. Cast with the table are a couple of semi-circular

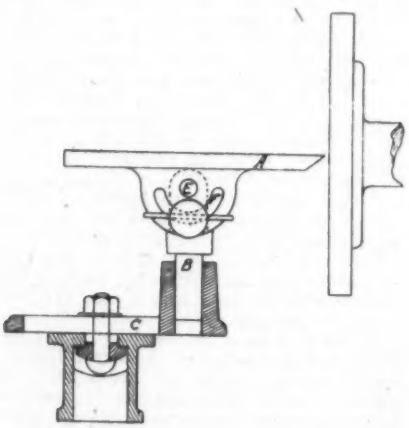


FIG. 1.

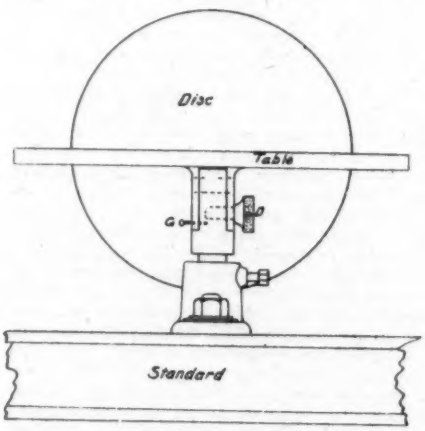


FIG. 2.

A SAND PAPERING DISC CONSTRUCTED ON BACK SCREW OF LATHE.

double ended headstock, the outer end having a left-handed screw for large chuck turning. More often than not this end of the lathe is idle, and, in fact, is very rarely used. The device here illustrated suggests the adoption of this end of the lathe to a sand papering device.

Invariably lathes such as those mentioned above have contrivances for sustaining the rests for chuck-brackets having a centre about one inch from the bottom of the plate, one of these brackets having a concentric slot cored out about $\frac{1}{2}$ an inch in width. The distance between the brackets is machined to a definite size.

The casting of the rest is machined to suit the hole in the rest holder and also to make a working fit for the table. Holes are then drilled through the

two brackets of the table and the rest, and a pin E is inserted so that the table works on the rest easily. Through the slot F and into the rest B a hole is tapped suitable for the thumbscrew D, the latter having a shoulder turned on so that it will secure the table to the rest when screwed up. The small piece of round steel through the head of the thumb-screw is for greater leverage in tightening, and is made easy fitting. On the opposite side to the thumb-screw two marks are made, one on the bracket and the other on the rest, which marks coincide when the table is in a horizontal position. A number of marks can then be made on the bracket so that definite angles may be obtained when the table is revolved for these marks to coincide with the mark on the rest. A number of small holes can also be drilled through the bracket and one into the rest to receive a safety pin G for suitable angles.

The disc to which the sandpaper is attached is a piece of well-seasoned sycamore secured to a chuck to suit the lathe by means of wood screws. It is not advisable to remove the metal chuck after having properly turned the wood disc perfectly true. The sand paper is best attached by means of liquid glue. Many readers will question the advisability of using wood for the disc owing to the liability of its being affected by the humidity of the atmosphere, but the writer has had one of 15 inches diameter in going order for over six months. Each time the sand paper was changed the disc was trued anew, and the device has proved a useful and serviceable one in the pattern shop.

Business Methods for the Ironfounder.

Accounts and their Uses.

By Percival P. Richards, A.C.A.

The last article described a useful form for the preparation of the annual accounts, consisting of:—

(1) A Balance Sheet disclosing the assets and liabilities.

(2) A Manufacturing Account for each separate department of the business, showing the gross manufacturing profit earned in each department.

(3) A General Manufacturing Account, being a summary of the Departmental Manufacturing Accounts, showing the total gross manufacturing profit earned.

(4) A General Trading Account of the business, showing all the trading expenses, properly grouped, and the net trading profit earned during the year.

(5) A Profit and Loss Account, showing the amount of profit available for distribution.

It was stated that the object of these accounts is:—(1) To show what profit has been made; (2) to show how the profit has been made; (3) to provide a basis for future costs; (4) to provide figures and information for use in the next year in guiding the policy of the management.

In order to make the accounts of practical use it is necessary to reduce the figures to a common factor and to obtain the cost per ton of casting produced. The total "saleable or useable" weight of castings produced during the year must first be ascertained for each department separately. This should be done in two ways. The first method is to take the weights as shown by the foundry output books (allowing for defective castings broken up and also for fettlings where castings are weighed before cleaning). The second method is to adjust the total net weights shown in the sales book with the stocks of finished castings at each end of the year, thus:—

	Tons.
Stock of finished castings, January 1	—
Add castings for foundry use	—
Add sales as per Sales Books	—
Deduct stock of finished castings, Dec. 31 ...	—
Difference being weight produced during year	—

Subject to the allowances named, the results obtained by the two methods should agree. If the figures differ to any appreciable extent it may be that wages are being paid on weights which are in excess of the true weights of castings made, or that goods are being sent out and not charged. It is always advisable to obtain both sets of figures, as discrepancies of different kinds are brought to light by so doing.

The output or production weight for each department is obtained in this manner, and the "cost per ton of castings produced" is calculated for each item in the Departmental Manufacturing Accounts. In a similar manner the gross profit per ton of casting produced is obtained.

Each item under the heading of Manufacturing Expenses (Trading Account Section) is dealt with in the same way, the other items in the General Trading Account being calculated on the basis of "cost per ton of castings sold," although some founders may prefer to take royalties and depreciation on the "production" basis rather than the "sale" basis.

A second set of figures should be prepared to show the percentage value of each item in the Departmental Manufacturing Accounts and the General Trading Account. The manufacturing costs are calculated on the *value* of the foundry output (each department separately) the value being obtained by adding the net value of sales to the value of the stock of finished castings at the end of the year and deducting the value of the stock of finished castings at the beginning of the year. The charges in the Trading Account are calculated on the value of the sales, subject to the exceptions already named. The resulting figures of a Manufacturing Account will then appear in the following form (detailed items being omitted):—

Materials Used in Manufacture.	Percentage on production value. Per cent.
Cupola materials (with details)	55
Moulding materials	8
Other materials	2
Wages paid	20
Total cost	80
Gross manufacturing profit	20
	100

These figures should be calculated to two places of decimals, and will vary in each department and each business according to the class of casting produced. The percentages shown above are not intended to be representative figures.

The tonnage cost figures and the percentage cost figures are to be tabulated so as to show three years' figures side by side for each set of costs and for each account, the tables thus comprising:—

(1) For each Departmental Account:—(*a*) Tonnage cost figures for three years; (*b*) percentage cost figures for three years; (*c*) figures in sterling for three years, eliminating shillings and pence for convenience.

(2) For the General Trading Account, three tables as above.

(3) For the Profit and Loss Account, three tables as above.

The following specimen table will illustrate the principle involved:—

Department Manufacturing Account, Comparative Tonnage Cost for Three Years.

	1910.		1909.		1908.	
	Details	Total.	Details	Total.	Details	Total.
CUPOLA MATERIALS	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
Hematite ...	3 9½		3 6		2 8	
Pig-iron	40 3		38 6		36 2½	
Scrap iron ..	14 1		13 2		12 8	
Other metals ...	0 6		0 5		0 4	
Coke	2 3½		2 5		2 2	
Limestone ..	0 1	61 0	0 1	58 0	0 1½	54 2
MOULDING MATERIALS						
Green sand ..	—		—		—	
Loam	—		—		—	
Small coals ...	—		—		—	
Plumago ...	—	1 2	—	0 11	—	1 1
OTHER MATERIALS						
Timber	—		—		—	
Stores	—	0 5	—	0 7	—	0 6
WAGES PAID.						
Pattern makers	—		—		—	
Core makers ..	—		—		—	
Moulders ...	—		—		—	
Cleaning and fettling ...	—		—		—	
Breaking metal and cupola charging ..	—		—		—	
Labourers ...	—		—		—	
General wages..	—	23 9	—	22 8	—	22 0
		86 4		82 2		77 9

A few hypothetical figures have been inserted to illustrate the use of the tables. With the complete set of tables for use, and a list of the three years' average market prices and average buying prices of metals and moulding materials, fluctuations in costs are brought to the notice of the management, and can be enquired into at the commencement of each year. For example, the total cost of cupola materials shown is 3s. more in 1910 than it was in 1909 for each ton of casting produced, due mainly to increases of 3½d. per ton on hematite, 1s. 10d. per ton of casting on pig-iron used, and 11d. per ton of casting on scrap iron used. Assuming the rise in market prices to account for, say, half of this increase, the balance of the increased costs must be due to one of several causes. These causes may generally be set down as:—(1) Making better class of castings; (2) bad buying, or (3) using metal of too good a quality for the jobs.

The buying question can be settled by comparing the average cost per ton of metal bought in each quality with the average market prices. If a better class of casting has been made in the department, then the average selling price per ton obtained during the year should show a corresponding increase. If neither of these points account for the difference, then the question of mixing of cupola metals should be investigated. By using all the sets of tables prepared and by adopting this process of elimination in regard to each item of increase and decrease in the costs (always taking into account local and special conditions), the reasons for the fluctuations can be traced and remedies applied in time to prevent similar occurrences in the next year. In this way leakages may be stopped and gross profits increased.

When expense items in the General Trading Account show fluctuations in the percentages and tonnage costs, the figures making up the particular totals can be further analysed, and the real causes thus located. Selling expenses in particular should be carefully watched, and the cost of every agency and salesman calculated on the sales effected by them in order to ascertain whether the expenditure is justified by the results. In practice many and varied uses will be found for the figures and results obtained from these tables, which it is not practicable to outline at present.

Further useful information may be obtained by tabulating year by year the average prices obtained for different kinds of castings in each department, allowance being made for freight included in the invoiced charges. The total weights of metal purchased each year should be accounted for by taking the total weights of castings sold during the year and adjusting with the stocks of raw metals and finished castings on hand at each end of the year. Any discrepancies, after allowing for waste, may be caused by errors in stock-taking or leakages in stock.

There still remains a most important use for the figures given in the comparative tables, as they are indispensable for costings purposes. The figures shown in the last completed account should form the basis of the costings in the ensuing year, and all items in the costings except the cost of metals and piece-work wages should be fixed in accordance with the details in these accounts, subject only to special alterations. If the cost of moulding materials in 1910 was 1s. 2d. per ton of casting and buying prices, etc., are the same in 1911 as in 1910, then obviously the correct figure to use in the 1911 costing is 1s. 2d. per ton of casting, and this remark applies to many other items of cost (see "Costings," "F.T.J.," June, 1910).

The only accurate way to determine the "oncost" or "establishment" charges for costings is to use the figures shown in the last accounts. These should be added in the form of a percentage on the invoice price, less freight (upon which no profit is made); the percentage figure used being taken from the percentage cost table as prepared for comparative purposes. Under no circumstances should the "oncost" figure be estimated, nor should it be taken approximately, as a small difference in this figure when estimating will make a large difference in the profits at the year end. The oncost figure used should be taken to the nearest half per cent. to the amount disclosed by the percentage cost table. For example, if the table shows the oncost charges for 1910 to be 19.76 per cent. (calculated on selling prices), then 20 per cent. should be taken as the oncost figure for 1911, no variation of more than one quarter of one per cent. being allowed.

The fourth use for the figures, as mentioned earlier, will be dealt with in an ensuing article.

American Foundrymen's Association.

Convention at Pittsburg.

At Pittsburg, on May 23 last, the joint Convention of the American Foundrymen's Association and the American Brass Founders' Association was opened in the Exposition building, under the presidency of Major J. T. Speer, President of the American Foundrymen's Association. Addresses of welcome were given by representatives of the city of Pittsburg and the Chamber of Commerce, to which Mr. A. D. Howard, Vice-President of the American Foundrymen's Association, responded.

The President gave a brief address, in which he pointed out that great strides have been made in the past few years in the science and art of founding, as a result of co-operation and interchange of ideas among foundrymen.

Dr. Richard Moldenke, Secretary of the American Foundrymen's Association, then presented his annual report, which showed a total membership of 692, and a balance in the treasury of $1,541. This membership, however, will probably be reduced slightly when the present arrangement with the individual members of the Foundry and Manufacturers' Supply Association, which was recently dissolved, is terminated on July 1.

At the point session of the Associations the Papers read included the following:—"Production Costs," by Ellsworth Taylor; "Economical Insurance for Foundry Properties," by S. G. Walker; "Foundry Costs," by F. E. Weber; "Why Cost Systems Fail," by S. E. Nold; "Standard Test Bar for Cast Iron," by Richard Moldenke.

At a separate session of the A.F.A., the following Papers were presented and discussed:—"Cupola Melting Practice," by P. Munnoch; "Cupola Practice," by R. H. Palmer; "The Briquetting of Metal Borings," by Dr. Richard Moldenke; "Mechanical Charging of Cupola," by G. R. Brandon; "Progress in Heated Foundry Mixers," by J. B. Nau; "Titanium in Iron Castings," by C. V. Slocum; "Defective Castings," by J. M. Perkins; "Moulding Machine Practice," by E. H. Mumford; "Machine r. Hand Moulding," by J. Alexander.

At the joint session on Wednesday morning, May 24 the Papers included "The Permanent Mould," by E. A. Custer; "The Foundry at Close Range," by B. D. Fuller; "Core Making and Core Machines," by A. M. Loudon; "Core Room Practice," by F. A. Coleman; "Recent Developments in Pyrometry," by S. H. Stupakoff; "Waste Sands of the Foundry," by S. A. Capron.

Later in the day a steel session was held, when a Paper on "Open-Hearth Steel Foundry Practice" was presented by R. E. Bull. Other Papers were "The Manufacture and Annealing of Converter Steel Castings," by Bradley Stoughton; "The Small Open-Hearth Furnace for Steel Castings," by W. MacGreggor; "The Practicability of the Induction Furnace for the Making of Steel Castings," by C. H. Von Baur; "The Héroult Electric Furnace for Steel Castings," by Dr. P. Héroult; "Microscopic Structure of Iron and Steel," by Prof. W. Campbell; "Titanium in Steel Castings," by C. V. Slocum.

At the session on Thursday the Papers included the following:—"Vanadium in Iron and Steel Castings," by G. L. Norris; "Foundry Construction," by G. K. Hooper; "Electric Motor Drive for Foundries," by B. Wiley; "The Rotary Blower for Cupola Use," by R. H. Rice; "The Application of Lifting Magnets for Foundry Work," by H. F. Stratton; "Pattern Equipment," by W. S. Giele; "Titanium in Malleable," by C. H. Gale; "The Physical and Chemical Characteristics of Malleable Iron," by W. P. Putnam; "The Equipment of Air Furnaces using Oil as Fuel," by N. W. Best. Also included in the programme for that day were excursions to foundries and steel works, and an entertainment by the Foundry and Machine Exhibition Company to members, ladies, and guests attending the Convention.

On Friday, May 26, at a session of the A.F.A., the Papers on the programme included:—"Gas Cavities, Shot and Chilled Iron in Iron Castings," by Thos. D. West (see June issue of FOUNDRY TRADE JOURNAL); "Manganese and Silicon in the Foundry," by A. E. Outerbridge, Jr.; "Instruction Paper on Phosphorus," by H. E. Field; and an address on "The Foundry Foremen's Educational Movement," by D. O. Wilson. The election of officers and other business concluded the session.

Election of Officers.

Major J. T. Speer was unanimously re-elected President of the American Foundrymen's Association for the ensuing year, and as in previous years, Dr. Richard Moldenke was re-elected Secretary and Treasurer. The following district Vice-Presidents were elected:—First district—Mr. F. B. Farnsworth, New Haven, Conn.; second district—Mr. W. D. Miles, Buffalo, N.Y.; third district—Mr. Walter Wood, Philadelphia; fourth district—Mr. A. E. Howell, Nashville; fifth district—Mr. R. A. Bull, Granite City, Ill.; sixth district—Mr. T. W. Sheriffs, Milwaukee; seventh district—Mr. D. R. Lombard, Augusta, Ga.; eighth district—Mr. S. B. Chadsey, Toronto.

It was decided by the meeting that Buffalo should be the place for holding the 1912 Convention.

American Brass Founders' Association.

At the joint session on Tuesday, the presidential address of Mr. N. K. B. Patch, in his absence, was read by Mr. L. W. Olson. The report of the Secretary, Mr. W. M. Corse, showed that the membership, now 287, had increased by 5½ per cent. during the past year.

The Papers presented at the meeting included the following—"The Analysis of Manganese Bronze," by J. R. Huber; "The Corrosion of Brass Foundry Products," by Wm. Vaughan; "The Efficiencies of Furnaces," by Dr. J. W. Richards; "The Pyrometer and the Aluminium Foundry," by H. W. Gillett; "Bronze Melting and Pouring Temperatures," by C. P. Karr; "Non-ferrous Foundry Economies and Refinements," by E. A. Barnes. Other Papers before this body were "The Determination of Nickel in Alloy," and "The Effect of Repeated Melting on Manganese Bronze," by J. L. Jones. The latter described experiments made in remelting manganese bronze to determine the average loss in crucible and open-flame furnaces, which was ascertained to be about 4 per cent.

Election of Officers.

Mr. L. W. Olson, Ohio Brass Company, Mansfield, O., was elected President for the ensuing year, and

Mr. W. M. Corse, Lumen Bearing Company, Buffalo, was re-elected Secretary and Treasurer. The Vice-Presidents were Messrs. F. W. Thompson, Orford, N.J.; R. T. Roberts, Hastings, N.Y.; P. F. Augenbraun, Stamford, Conn.; G. H. Clamer, Philadelphia; S. Mueller, Decatur, Ill.; R. C. Faunt, Chicago; H. W. Gillett, Detroit; J. Cessna Sharp, Chattanooga, Tenn.; N. K. B. Patch, Toronto; Richard R. Mitchell, Montreal.

At the annual meeting of the Associated Foundry Foremen, Mr. R. B. Thompson, of the Buffalo Pitts Company, was re-elected President, and Mr. H. McPhee was re-elected Secretary. Mr. W. H. Woods, President of the Pittsburg Foundry Foremen's Association, was elected first Vice-President.

The Papers.

Abstracts of some of the Papers presented are published in this issue of the FOUNDRY TRADE JOURNAL. The paper by Mr. T. West, on "Gas Cavities, Shot, and Chilled Iron in Iron Castings," was presented in our last issue.

The Prevention of Drawholes in Machine-Made Castings.

BY T. F. H.

Most founders experience considerable trouble when making thick, chunky, though not necessarily large castings; in fact, the troubles are mostly met with in small castings such as gear pinions, blanks, etc., which are produced in such quantities as to make it almost impossible to feed them separately with a feeding rod. At any rate, feeding with rods would be very inconvenient and expensive.

As an example may be taken a gear pinion blank 5 in. deep by 8 in. diameter, with a 2½-in. round hole in the centre. There is no difficulty in making these castings one at a time in 12-in. boxes, but owing to the large numbers generally required it is necessary to put them on a machine, say eight in a box, 3 ft. square. It is then that the troubles commence with dirt, sinkings, drawholes, etc., which, if not perceptible on the rough castings are soon found when they undergo machine shop operations. Quite a number of foundry managers and foremen will not entertain the idea of putting such jobs on a machine or plate, for the above reason, as they consider it too risky and expensive for large quantities of these castings to go into the machine shops and be returned faulty, when perhaps some of them have been going through their last operation of teeth cutting. If, however, particular attention is paid to the dimensions of the runner bushes, downrights, and gits, this trouble will be overcome very effectively.

The writer made some gear pinion blanks of the dimensions given above, *i.e.*, 5 in. deep by 8 in. diameter, with 2½-in. hole, eight in a box, and cast them with what most moulders would call a runner plenty large enough. Most of these castings showed deep drawholes, and others which passed the first inspection were scrapped in the machine shops owing to drawholes being found after the teeth were cut. The runners, etc., were then increased to the following sizes:—Runner bush, 7 in. deep, 6 in. wide, and 1 ft. long; downright runner 3 in. to 2½ in. diameter; U-shaped git, 1½ in. deep by 1½ in. wide at the top and 1 in. wide at bottom. Since this not a single instance of sinking or drawholes has been experienced with the castings, and they have not a blemish when finished.

It is essential that the runner bush be large enough to feed the downright runner and that the downright be large enough to feed the gits (or gates). The bush must be kept full up to the very top while casting and it must be left full when the moulds are full. No risers are required, but a small vent must be put on the top of each casting so as to allow the accumulated gases to escape; the vent wire must not exceed ⅛ in. diameter or the metal will run through and spread all over the box, in which case the runner pressure, which it is most essential to have, is lost.

The above remarks apply to all weighty castings, but the writer has selected gear pinions as a good example, and it will be found in all jobs where the castings are required in large numbers which necessitate machine or plate moulding, that sinking, drawholes, and the general quality of the casting can be governed by the runners. Many ironfounders place great faith in the addition of aluminium to the iron to prevent blowholes, drawholes, etc., but the results are doubtful and never reliable, for in trying to cure one evil others are invariably created. One evil which is always prominent is that the aluminium sweats through to the face of the casting and forms a hard skin which plays sad havoc with the machine tools.

Carbon Blocks for Blast Furnaces.

As noted in the REVIEW of March 31 last, amongst the exhibits at a conversazione of the Cleveland Institute of Engineers were some Erkrath carbon blocks for lining the hearth, well and bosh of blast furnaces. These were exhibited by Messrs. Jarvis Bros., Limited, of Middlesbrough, and from the recently published "Transactions" of the Institute we take the following additional particulars: Molten iron at a high temperature holds carbon in solution, which deposits out when the metal is lowered in temperature (by contact with the cooled walls of the well) and forms a skin or layer of carbon, which ultimately protects the bricks from the action of the molten metal and slag. Over 100 of the most modern Continental blast furnaces have been lined with carbon blocks during the past eight years. The cost of carbon blocks per ton is practically twice that of firebrick, but the specific gravity being 1.25 as compared with 1.9 for firebrick, the proportionate cost of a lining is not so great. This is not, however, a true basis for comparison, the cost per ton of iron produced being the only figure of importance. If a furnace produces as much iron in a fourth of the time as a similar furnace lasting four times as long, the cost of lining per ton of iron would be the same, but as the cost of lining forms a small part only of the total cost per ton, the other standing charges remaining approximately the same, the increased production reduces the total cost per ton. Of course, where an ironmaster is satisfied with a weekly output of a few hundred tons per furnace, firebrick will probably continue to answer the purpose. Apart from the question of being able to withstand hard driving successfully, the advantages of the carbon block lining amongst others are claimed to be:—(*a*) The saving of the metal forming the "old horse," which will frequently pay the whole cost of lining the hearth and well. (*b*) The saving owing to less variation in the quality of the iron produced, due to the form of the furnace being maintained, it being probable that the quality going off is frequently due to the taper of the bosh becoming hollowed out by the action of slag and iron, so that fine material finding its way down the side of the furnace lodges there and accumulates, afterwards coming away with a rush into the well and spoiling the cast. (*c*) The saving due to the avoidance of "breaks away" from the well of the furnace. (*d*) The saving in time, labour and material when the furnace has to be re-lined, as a new shaft lining only will usually be required, the carbon bottom and well being permanent.

The Action of Heat on Fireclays.

A discussion on the behaviour of fireclays under heat took place at a recent meeting of the Birmingham Metallurgical Society, when a Paper, entitled "Some Notes on the Action of Heat on Fireclays," was contributed by Dr. J. W. Mellor. In the absence of the author, the Paper was read by Mr. W. J. Rees.

Fireclay, the author premised, might be conveniently regarded as a mixture of clayite and kaolinite—which for convenience he would in the Paper call clayite—along with quartz, colloidal silicic acid and fluxes—mica and felspar. The clayite largely predominated, and for the purpose of the Paper the organic matter and a few other minerals which occurred in small quantities need not be considered. The diagram, Fig. 1, was given illustrating observations made by Dr. Mellor with a sample of fireclay which, having been dried at 110 deg. C., was heated on a gradually rising temperature, with a thermo-couple immersed in the clay and connected with a recording pyrometer.

An enlarged photograph of a curve (Fig. 2) obtained with a china clay containing no silicic acid was also shown. This, Dr. Mellor explained, was made in an attempt to estimate the thermal value of some of the reactions now under consideration. The heating curve (Fig. 1) showed a terrace just below 200 deg. This corresponded with the decomposition of the colloidal silicic acid. If the clay contained no colloidal silicic acid (and one or two hydrated alumino-silicates), there would be no terrace at A. No special change occurred in the heating curve until just over 500 deg., when the clayite decomposed into free silica, free alumina and water. The reaction could be symbolised thus: $Al_2O_3.2\,Si.O_2.2H_2O \rightarrow Al_2O_3 + 2\,Si\,O_2 + 2\,H_2O$. This change produced another terrace, B, in the heating curve. Both changes were attended by an absorption of heat, and the terraces were produced by a retardation in the rate of heating. The dotted line in the diagram showed the curve which was produced when a substance undergoing none of these changes was heated.

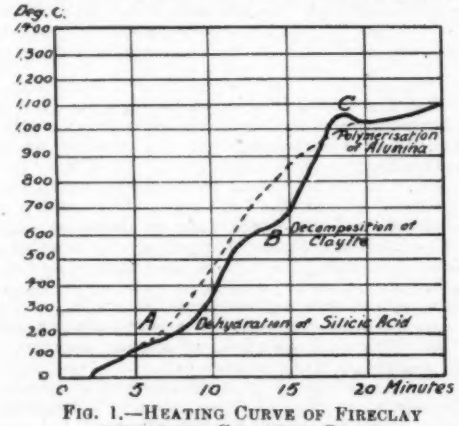


FIG. 1.—HEATING CURVE OF FIRECLAY CONTAINING COLLOIDAL SILICA.

Just over 800 deg., the alumina which was formed by the decomposition of the clayite underwent some kind of change which was accompanied by an evolution of heat. The result was a kink, C, in the heating curve. The heating curve of a typical fireclay thus showed three well-defined changes; (1) dehydration of silicic acid and silicates, (2) decomposition of clayite, and (3) polymerization of alumina. If the clay was heated still further, the alkalis began to volatilise, and, under suitable conditions of temperature, the free alumina recombined with some of the silica, forming an aluminium silicate, Al_2O_3, $Si\,O_2$, which appeared in the fired clay in the form of needle-like crystals of sillimanite. These crystals formed between 1,200 deg. and 1,300 deg. At still higher temperatures the clay began to sinter to a more or less stone-like mass, softened at, say, 1,670 deg., and melted at just over 1,700 deg. to a brown-coloured, viscid fluid. Dr. Mellor summarised these statements in the following table:—

110 deg. C.—Loss of hygroscopic moisture, decomposition of silicic acid and other colloids.

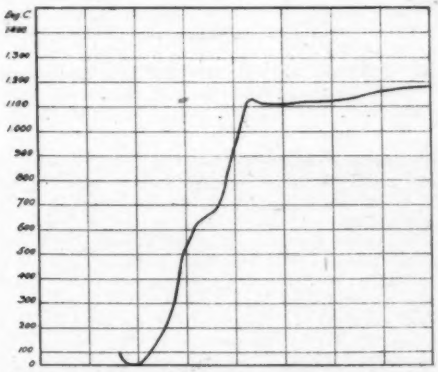


FIG. 2.—CURVE OBTAINED WITH A CHINA CLAY CONTAINING NO SILICIC ACID.

500 deg. C.—Clayite decomposes into free alumina, free silica and water.

800 deg. C.—Alumina polymerizes.

1,200 deg. C.—Alumina and silica recombine to form sillimanite.

1,500 deg. C.—Sinters to a stone-like mass.

1,650 deg. C.—Clay softens and loses its shape.

1,700 deg. C.—Brown viscid fluid.

It might be thought that some of these statements required proof. The statement regarding the dehydration of silicic acid was based on the development of a terrace similar to A when silicic acid alone was heated, and also on the action of dilute solutions of sodium carbonate on such clays. The theory that clayite and kaolinite decomposed at 500 deg. into free silica, free alumina, and water, and not into an aluminium disilicate and water (Al_2O_3, $2\,Si\,O_2$. $2\,H_2O \rightarrow Al_2O_3$, $2\,Si\,O_2 + H_2O$) was mainly based on the following facts:—

(*a*) Clay dehydrated at 500 deg. can be partially rehydrated. This is probably a rehydration of the alumina and silica.

(*b*) The changes in specific gravity, hygroscopicity, and solubility in acids of clayite calcined at temperatures between 500 deg. and 1,000 deg. resemble the changes in alumina derived from calcined aluminium nitrate.

(*c*) The acceleration in the heating curve at C is also produced by alumina derived from calcined aluminium nitrate.

It was also interesting to note that this decomposition of alumino-silicates into free alumina and silica was not confined to clays, because it was well known that many native silicates which are very slowly attacked by acids break down quickly if the silicate is

first calcined at dull redness. The explanation he had just indicated furnished, in Dr. Mellor's opinion, a key to the most probable interpretation of the phenomenon. Similarly, the so-called polymerization of many oxides on calcination, whereby they became very resistant to the action of solvents, was well known to analysts.

The formation of sillimanite had been demonstrated by the optical properties of the crystals, and by chemical analysis. The crystals had been isolated. If, therefore, they rejected the view that clayite decomposed as he had stated, they still had to assume a decomposition of the hypothetical $Al_2\ O_3, 2Si\ O_2$ at just over 1,200 deg. in order to account for the formation of these crystals $Al_2\ O_3$, SiO_2. The hypothesis he had indicated appeared to him the simpler interpretation, and fitted all the facts known to him.

The contraction which took place when a fireclay was heated was the joint effect of several changes. Crystalline quartz, for instance, expanded about 14 per cent.; crystalline felspar on fusing expanded about 6 per cent.; alumina contracted nearly 40 per cent.; the silica underwent very little change.

When air-dried clay was gradually heated there was a slight expansion at just over 110 degrees; then a slight contraction which continued up to 500 deg.; after that there was a slight expansion, and this was

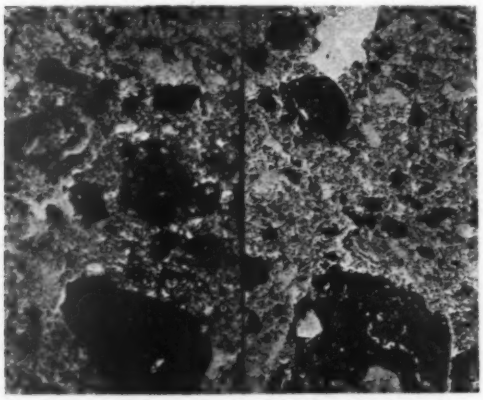


FIG. 3.—RAW, UNFIRED.

FIG. 4.—FIRED ONCE AT 1,100 DEG. C.

followed by a steady contraction. The two expansions noted appeared to correspond with a slight disintegration of the clay when the hygroscopic moisture was driven off at about 110 deg., and when the clay decomposed at just over 500 deg. If a piece of clayware was heated too rapidly while these changes were going on the piece might rupture owing to the development of so-called "fire-cracks."

The main contraction of a firebrick at above about 900 deg. was due to a change analagous with the universal tendency of liquids to assume a shape which presented the smallest possible surface area, namely, a sphere. As soon as the fluxes in the clay had softened, they commenced to draw the more refractory grains into closer and closer contact. The whole piece was trying, so to speak, to assume the form of a sphere. Contraction only ceased when the grains had been pulled close together by the fluxes, so that the whole formed a compact non-porous mass; and when the clay was high in fluxes the body would appear like vitreous stoneware. All the time the fluxes were doing this work, they were dissolving the more refractory clay and quartz. If the clay was low in fluxes, the fluxes would soon become saturated with clay and quartz and form a solution which was practically infusible at the given temperature. The brick must then be heated to a higher temperature before the solution could melt and the fluxes continue their work of (1) dissolving the more refractory materials, and (2) pulling the grains into closer contact.

There was a curious difference in the contraction-changes which occurred during the repeated firing of the two types of fireclay—or rather of firebricks, etc., made from the two types of fireclay. The vitrifiable fireclays, when subjected to the gas engineer's test, gave a rather high contraction, and the manufacturer had more difficulty in keeping his goods up to specification than when the non-vitrifiable fireclays were used. The contraction followed a definite law. If $n-1$ represented the number of times the brick had been fired, and the time-temperature curve of each firing was the same, the contraction on the nth firing was, according to the author's measurements, $\frac{a}{1 - b}\ n$ where the constants a and b depended upon the time-temperature curves, and on the nature of the mixture used in making the firebrick.

During the past year, the author investigated the value of these constants. He found that the contraction of fireclays low in fluxes soon reached a maximum when the firing conditions were constant.

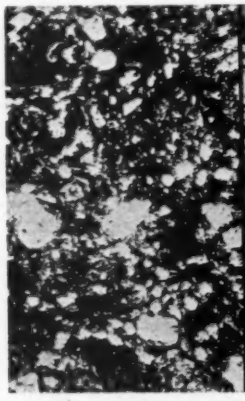


FIG. 5.—FIRED ONCE AT 1,350 DEG. C.

FIG. 6.—FIRED 7 TIMES AT 1,350 DEG. C.

After that the fired bricks began to expand. If the firing temperature was then raised contraction again set in, reached a maximum, and was followed by a slight expansion. This expansion puzzled him for some time. As far as he had been able to make out, the fluxes were saturated when the maximum contraction occurred, and the fluxes were no longer mobile enough to do their work of pulling the grains together. The brick had then attained its maximum crushing strength. Any further heating was followed by a reduction in the crushing strength. In other words, the expansion was produced by a disintegration of the brick. The brick also lost, as already indicated, a small amount of alkali at each firing.

As to his use of the term vitrifiable and non-vitrifiable fireclays, he thought these terms or something equivalent were necessary, because the majority of fireclays could be grouped into one or other of the two classes. By a vitrifiable fireclay or a fireclay high in fluxes, he understood a fireclay which vitrified to a stone-like mass at a comparatively low temperature, say, cone 18, and yet retained its shape above, say, cone 28. The non-vitrifiable fireclays were comparatively low in fluxes and exhibited the phenomenon of maximum contraction already referred to. It was a

great mistake to suppose that because a clay was comparatively high in fluxes, say 5 to 6 per cent., it would not be refractory when tested according to the gas engineer's specification.

If the vitrifiable fireclays exhibited no abnormal tendencies to split or dunt on cooling they made valuable bricks, crucibles, etc., for resisting the action of molten fluxes at high temperatures. But these clays showed to best advantage when blended with other less vitrifiable clays. What he had called the non-vitrifiable fireclays did not bloat at high temperatures, whereas many, or rather most vitrifiable clays developed a spongy structure owing to development of gases or vapour when heated a little above their temperature of vitrification.

Dr. Mellor's remarks on the volume changes which occurred on heating fireclays were summarised as follows:—

110 deg. C., Slight expansion.
110 deg.—500 deg. Slight contraction.
500 deg, Slight expansion.
600 deg. Contraction of alumina sets in.
800 deg. Expansion of quartz commences.
1,000 deg. Fusion and expansion of felspar, and main contraction commences.

The subsequent behaviour of the fireclay depended on whether a vitrifiable or non-vitrifiable fireclay was in question. Vitrifiable fireclays contracted to a maximum below, say, cone 18, forming a stone-like, non-porous mass which did not bloat below the softening temperature, say cone 28 and upwards.

Non-vitrifiable fireclays exhibited a maximum contraction which varied with the temperature when the maximum contraction had been attained. Subsequent heating at that temperature was attended by a slight expansion, and a slight disintegration of the brick. Subsequent heating at a higher temperature was followed by a further contraction which attained a maximum as before.

About six years ago, Dr. Mellor put forward the view that the decrease in the crushing strength of certain refractory goods on repeated firing was due to two conditions: (1) the gradual loss of alkali by volatilisation (2) the strains set up owing to the growth of local patches of crystals. A substance in a crystalline condition, he said, occupied a less volume than the same substance in a vitrious condition. If, therefore, local patches of crystals were produced in a vitrious body it followed that local contractions must be produced, and local strains leading to rupture must also be produced. The annexed micrographs well illustrated the growth of the crystals in repeatedly-fired refractory goods. Fig. 3 was the raw unfired body; Fig. 4 represented the same body fired to about 1,100 deg.; Fig. 5, the same body fired once at 1,350 deg.; and Fig. 6 the same body fired 7 times at 1,350 deg.

Zoellner, two years ago, put forward the view that the crystals made the body tougher and less liable to fracture. At first sight it did look as if the anastomosed crystals would make the body tougher, but when the comparatively great contraction strains set up during the passage from the vitrious to the crystalline condition were taken into consideration, it seemed to him that Zoellner's view was not sufficiently comprehensive.

Discussion.

Mr. A. H. Hiorns said that in the manufacture of artificial stones with lime and silica brought together by moisture, it was at somewhere about the temperature of 200 deg. mentioned by Dr. Mellor that the materials united and formed a compact stone. When this was first brought to his notice he had considerable difficulty in understanding it, but he supposed it was connected with that first point, the loss of water and the decomposition of silicic acid. Still that did not explain that point. At 500 deg. did complete dehydration take place? Again, did firing with the bricks and in the furnace itself at different temperatures (raising the brick to comparatively high temperatures which were afterwards cooled down again) go on occurring and recurring? Did they get these reverse changes taking place? He understood that at 800 deg. polymerisation took place and at 1,200 deg. the alumina and silica recombined. Did these changes reverse again on cooling? One very strange point was that with some clays holding 5 per cent. of impurity, such as alkalis, the brick was still very refractory.

Mr. Spittle said that he would like an explanation why a brick at about 1,200 deg. first expanded and as the temperature was raised contracted, then at 1,300 deg. expanded again, after which there was a further contraction, and that at about 1,400 deg. after cooling and heating again, say, seven or eight times, the brick gradually assumed a crystalline structure and there was a gradual contraction. Was that so?

Mr. Rees: Yes. Dr. Mellor says the non-vitrifiable clay exhibited the maximum contraction at various points.

Professor T. Turner said he noted that the author stated that crystallization led to contraction. That might be so in a firebrick, because they had holes in a firebrick; it was a porous material and the re-arrangement might lead to contraction. The general thing was that if they had a solution and the body crystallised from solution there would be expansion, but if they had a vitreous body and it crystallized the re-arrangement led to expansion. That was the general rule, but Dr. Mellor considered that was not the case with fireclay. In connection with the point just over 1,000 where polymerization of alumina took place, which was the point at which the clay suddenly became strong as regards the crushing strength, he had made a number of tests, taking rectangular pieces of clay all made in the same mould and of the same mixture and then baking them at different temperatures, taking them step by step up to over 1,000 deg. He found they were all the same strength between 900 deg. and 1,000 deg., and that then the strength of some suddenly increased and beyond that they all had the same strength again, but much higher. One could understand in polymerization the grouping together of a number of molecules might result in the strengthening which had been observed.

Mr. W. J. Rees, in reply to Mr. Hiorns, said the whole of the moisture was given off at 500 deg. Mr. Hiorns had asked whether, after the changes which occurred on heating, some of the compound forms returned on cooling to their original condition. He (Mr. Rees) did not think that that was so in the case of fireclays. For instance, when fluxing occurred they would not on cooling get a break-up of the fluxed compound into its original constituents. In his opinion, the microscopic structure of fireclay was a vastly more difficult subject than the microscopic structure of metals, because of the great difficulties in getting the sections. It was a very difficult thing to get a really satisfactory section of a fireclay, though one could get some information by dyeing. With regard to the question as to a clay with 5 per cent. flux being still a refractory clay of value, Dr. Mellor showed that those fluxes dissolved a certain amount of silica and alumina and very quickly became saturated. The fluxes dissolved so much silica and alumina that they were no longer fluxes. Mr. Rees pointed out the importance of the ratio of the total fluxes to the proportions of silica and alumina present. If the alumina was high in proportion to the silica then, as before stated, it was possible to have a comparatively large percentage of fluxes present without the refractoriness of the clay being destroyed.

Core Room Management and Materials.*

By H. M. Lane.

In many cases by the proper selection of supplies and equipment a core room manager may more than cut core costs in half. Such savings as this can rarely be made in other departments of the foundry. In one case, where rye flour was being used as a binder, investigation showed that the workmen were using one part of flour to six parts of sand. On the amount they were consuming, they were wasting four barrels of rye flour a day, even with hand mixing. A mixing machine was installed, and with this equally good cores, so far as strength was concerned, and very much superior as to venting quality, were made at a ratio of one part of flour to thirty-six of sand, which saved another four barrels of flour per day. In another plant the following ratios were in use: Flour, 1 to 12; rosin, 1 to 12; oil, 1 to 40; but, after installing a sand-mixing plant, they doubled the ratio in all cases.

Frequently it pays to have two or more brands of sand for different classes of work; for instance, a sharp silica sand or beach sand for oil-sand cores and clay or loam sand for very heavy work, and a finer sand containing some clay for small work, which must be smooth on the inside.

The effects of good core room management are not seen in the core room alone, but in the foundry and machine shop as well. When cores are properly turned out the castings loss from bad cores should disappear, and in many plants this is a serious item.

To resist heat a material for cores must be used which will not fuse at the temperature of molten metal, and which, at the same time, is capable in itself of resisting great pressure. Silica in the form of sand has come to be universally recognised as the base of a core. The grains must be united with something which will be disintegrated by heat, and this has led to the universal use of some carbon compound; hence all core binders are carbon compounds, and most of them char or burn out at relatively low temperatures. The one exception to this binder rule is found in the use of the natural binder, clay, but where this is relied upon to any great extent the friability of the core must be insured by incorporating sawdust, coke, or some other material which will burn out and crush.

Binders.

The binder must act not only after the core is dry, but must hold it in position during the drying, and prevent its sagging or deforming. George H. Wadsworth, in discussing the core problem, has referred to the green and the dry binders; that is, the binder which holds the sand in position while green and that which holds it after it is dried. For certain classes of machine-made cores it has been found necessary to add some binder like flour to act as a green binder, while oil acts as the dry binder. In cores made on the jarring machine, or in many cases of hand-made cores, water forms the green binder, while the oil or compound forms the dry binder. In most cases the binder ratio can be cut down by working the mixture fairly wet, and frequently the driving of the moisture out of the sand seems to steam or carry the binder through the entire mass. In some cases it even concentrates it near the surface, giving a strong skin with a soft interior, which is frequently the most desirable arrangement.

Where cores are made up several days in advance of the time they are used and stored they have a tendency to absorb moisture; also in certain foundries it has been the practice to leave cores in damp moulds over night or for a considerable number of hours. In this case the core must be able to resist moisture. It is commonly supposed that this practice necessitates a core made with oil, rosin or pitch (black compound) as a binder. A change in the core room management, however, with proper provision for taking care of and protecting cores may make it possible to use cheaper binders to advantage, and it is here that the management of the core room should co-operate with that of the foundry, and so arrange the practice as to permit the use of the cheapest efficient binder available. Some of the other binders, such as flour, dextrine, molasses or glutrin, possess special advantages over the more distinctly moisture-resisting classes, and hence a wise management will provide a dry place for storing stock cores and arrange to have the cores placed in the moulds shortly before the moulds are to be poured. This will frequently permit the use of much cheaper binders, and the additional expense of keeping the cores in a dry place or of keeping them out of the mould until they are wanted is but a small part of the saving which may be effected.

Testing the Materials.

The core room man should be capable of testing and comparing sands and binders. When purchasing the sand from the same company different consignments may vary so greatly as to upset all of the calculations in the core room. One firm keeps on hand a quantity of a standard brand of raw linseed oil to be used as a test for comparing either sands or other binders. Cores are made of sand and this oil, in the form of bars, 1 in. square by 15 in. long. If two sands are to be compared, an equal number of cores is made from the known and the unknown sand, while if it is binders that are to be compared a known sand is used and an equal number of cores made with each of the binders to be tested. The cores are then broken on supports 12 in. apart. It has been found that two batches of cores made from the standard linseed oil and baked under different oven temperatures may vary greatly in strength, but by baking a set of cores from the standard oil and a set of the unknown class on the same plate at the same time, a good comparison may always be obtained. By this means a working idea as to the value of either sands or binders can easily be obtained.

In many cases where intricate or delicate cores are required it is cheaper to purchase a clear washed silica sand than to use local bank sand. This is particularly true when oil is used as a binder. Cores made of oil and silica sand require few rods, as they are strong. For other classes of work, and particularly where a smooth surface is wanted, it is frequently advisable to use a little clay with the sand. In all cases, however, where cores that will vent freely are wanted care should be taken to avoid the presence of any fine material in the core which does not partake of the nature of a bond. Water barrels or washing devices have been perfected and are used successfully for removing fine dust from the sand, and thus permitting the re-use of the coarser particles. This

* Extracts of a Paper presented before the Buffalo Foundrymen's Association.

sand washing costs but little and gives a superior product for making cores for many classes of work.

The storage of core sand is an important item. Where possible it should be stored under shelter, and it should contain as small an amount of moisture as possible previous to mixing. Serious irregularities in core room practice are frequently traceable to variations in the amount of moisture in the sand as it comes to the mixer, no account usually being taken of this original content of sand. Where sand is used in considerable quantity provision should be made for handling it economically. If a blend is being used which requires clay, and comparatively small quantities are being handled, the clay can be added in the form of clay wash to the mixer or to the material mixed by hand. Any foundryman melting over five tons of iron per day can afford a mixer, and would find it an excellent investment for preparing both core sand and facing sand.

Drying the Cores.

For the drying of cores an efficient oven is necessary. The temperature should be uniform throughout the oven, and the length of time necessary to dry any given core will necessarily depend to a considerable extent upon the bulk of volume to be considered. First, the water which is used with the binder must be expelled. This passes off as steam, and ample provision must be made for its exit from the core oven. After the moisture has been removed there is a chemical or mechanical action which goes on in the binder, according to the binder employed. Flour or dextrine must be baked just as bread or pie crust is baked. Oil like linseed oil must be oxidised and dried down to an adhesive skin. Black compound and rosin must be melted and caused to flow through the sand, and any volatile constituents driven off. Molasses must have its excess water driven off and be charred. Glutrin must have the excess water expelled and the material reduced to a solid consistency.

The temperatures required for drying different cores vary greatly, and the same binder treated under different temperatures has different properties. For instance, a core made with pure linseed oil will harden sufficiently for use in the air if given time enough. This is on account of the fact that the oil is slowly oxidised just as linseed oil hardens in an ordinary paint. Ordinary core oils, however, contain other constituents which have to be volatilised and driven out, and for this purpose a comparatively high temperature is necessary. Like oil a glutrin core will harden in the air if exposed in a dry place, but the material is hygroscopic and takes up moisture again if exposed in a damp place. If glutrin is baked at such a temperature that some of the constituents are charred it attains considerable moisture-resisting properties, and it is here that the success or failure of many plants with the use of this binder has occurred, the trouble being with the temperature obtainable in the core oven used.

In many foundries everything is sacrificed to rapid drying. The writer visited a foundry recently where they were using flour for most of their cores. The ovens were driven with coke fires directly beneath the cores, and frequently the core pans at the lower part of the oven when removed would be red hot around the edges and the cores smoking like a house afire. Upon breaking the cores open as they came from the oven the interiors of the larger ones were found to be green or doughy. Many of them were baked in ten minutes or less. On account of this oven practice it was necessary to use about three times as much binder as would have served had a slower baking been practised. In another foundry using glutrin the cores were hurried through the oven so fast that the interiors were still moist. As the metal poured in this case was brass, and as the cores remained in the mould but a few minutes before pouring, no bad results followed, but had this been an iron foundry and the cores left in the mould several hours, there would have been serious softening of the exterior portion of the core from the large amount of moisture remaining inside the core.

The Ramming of Cores.

In a brief Paper before the recent Convention of the American Foundrymen's Association, on the subject of "Core-making and Core Machines," Mr. A. M. Loudon writes as follows:

"Cores are made by a number of methods, when produced by hand from core boxes. In the case of cores made in halves and then pasted, the following would take place:—The core-maker takes the box, fills it with his core-sand mixture, and begins to ram it. When rammed up hard enough, using a rod or rammer for this purpose, he puts rods into the core, if he has not done this while ramming up the sand first put into the box. He then again fills up the box and rams as before. Then he butts all over sufficiently high enough to allow scraping off with an iron or wooden straight-edge, so that he will leave a level joint for matching the two halves when pasting. After scraping off, he cuts a gutter for the vent, and then uses the vent wire in cases where the cores are large enough to require this. This operation pricks the box, and ultimately destroys it.

"The above being the usual method employed, I wish to call your attention to the fact that when the core-maker rams a core he does so only on the spot immediately at the surface of the rammer, and at the same time displacing the sand in all the other parts near by. This results in his ramming over and over again at the same place, turning out a core unevenly rammed, hard and soft in spots, causing more blown and scabbed castings from faulty cores than from any other cause.

"Attention given to even ramming will develop a better quality in the core, as well as cheapen it. Foundrymen are, therefore, urged to give their attention to the study of machines for making cores in which even ramming and homogeneity of material is attained, for therein lies a source of economy in their shops."

Mr. Hans Spannagel, who, as we recently announced, has discontinued his office at Broad Street House, London, E.C., has accepted the appointment of commercial manager for Messrs. Schüchtermann & Kremer, of Dortmund, Germany.

The creditors of T. Longdin, lately carrying on business at Newton Foundry, 67, Holland Street, Manchester, as an ironfounder, are to send in particulars of their claims before July 17, to Mr. W. R. Sharp, of Messrs. Greenhalgh, Sharp & Company, 30, Brown Street, Manchester.

The firm of Rankin & Green, Budhill Foundry, Shettleston, Glasgow, of which Mr. Andrew Rankin and Mr. John Green were the partners, has been dissolved by the retirement of the latter. Mr. Andrew Rankin and Mr. William Steven will continue the business under the style of Rankin, Steven & Company.

Manganese and Silicon in the Foundry.*

By Alexander E. Outerbridge, Jr.

About thirty years ago I commenced a long series of investigations with manganese in connection with the special kind of cast iron used for making chilled cast-iron car wheels. Formerly such wheels were made entirely from cold-blast charcoal iron, a product peculiarly suited for the purpose. This metal was rich in

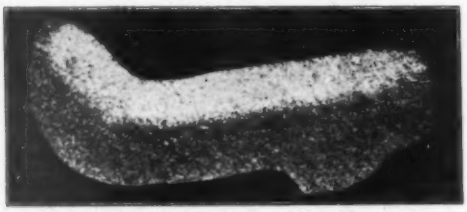


FIG. 1.—SECTION OF 33-INCH CAR-WHEEL CAST FROM TREATED IRON; SHOWING FINE WHITE CRYSTALS AND DARK GRAY.

carbon and comparatively poor in all of the other elements, viz.: Silicon, sulphur, phosphorus and manganese. Good car-wheel iron has approximately the following composition: Carbon, 3.242 per cent.; phosphorus, 0.403 per cent.; silicon, 0.776 per cent.; manganese, 0.391 per cent.; sulphur, 0.083 per cent.

Cast iron for chilled car wheels differs from iron for machinery castings or for general purposes mainly in its comparatively low silicon content, being less than one-half of the amount of silicon ordinarily found in iron castings and less than one-third the quantity often found in light castings such as pulleys. Nevertheless, the silicon in these good wheels was close up to the maximum amount permissible in chilled cast-iron car wheels having the requisite depth of chill (or white iron) in the tread to insure high mileage.

As long as cold blast charcoal iron was obtainable, little difficulty was experienced in maintaining the product up to the required standard. In course of time cold-blast charcoal iron became more and more difficult to obtain; "warm" blast was introduced for economy both in the quantity of charcoal fuel and in the time required for reducing the iron from its ore.

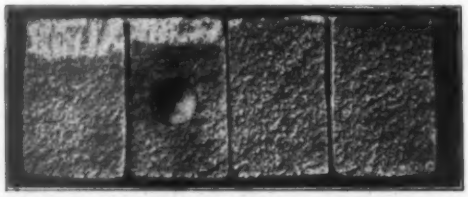


FIG. 2.—FOUR SPECIMENS CAST IN GREEN SAND MOULDS AGAINST A CHILL BLOCK ON ONE FACE.

Instantly the quality declined and then "hot blast" iron, made with anthracite coal, supplanted charcoal iron for almost all purposes, even the making of chilled cast-iron car wheels. This change in practice necessitated the introduction of more scientific methods in car wheel foundries.

* Extracts from a Paper read before the American Foundrymen's Convention, May, 1911.

It was well known that manganese caused iron to chill, and as long ago as the year 1880 the custom of introducing a certain quantity of high manganese iron into the cupola in car-wheel mixtures had already attracted attention. The tests which I was called upon in that year to make convinced me that a "manganese chill" on the tread of a car wheel was a spurious chill, very handsome to look at, but poor in wearing properties. The crystals are coarse and lamellar, they "spall out" or break away from each other when subjected to repeated taps with a hand hammer. Moreover, the white iron caused by high manganese in a chilling mixture is comparatively soft and may be drilled without great difficulty. The result of introducing high manganese irons in the cupola proved disastrous in car wheels when put to severe practical tests and the rule was therefore made that a manganese chill must be avoided.

In the course of these early investigations, however, a remarkable discovery was made, almost by accident. I found that if a very minute quantity of

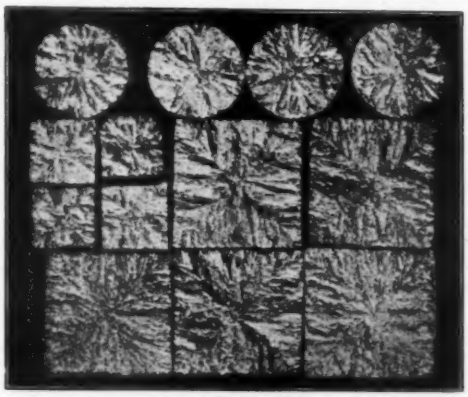


FIG. 3.—SPECIMENS CAST IN HEAVY IRON CHILL CUPS.

powdered ferro-manganese was placed in the bottom of a ladle and ordinary car wheel iron poured upon it several curious things happened: First, a very rapid circular movement, or rather motion in ripples from the edge towards the centre of the ladle, was immediately noticeable on the surface of the molten iron. This continued until the iron set, and was even apparent in the gates and risers of castings up to the moment of congealing. Second, when a chill test piece was fractured it was seen that the grey iron portion was very much darker in colour and of more open grain than that of a similar test piece poured from the same iron untreated. Third, the white iron or chilled portion of the test piece showed no appearance of a manganese chill, the only visible change being a slight reduction in the depth of the chill. Test bars were cast from this metal and also from the untreated iron. An average gain approaching 50 per cent. in tensile and transverse strength was recorded.

Analyses were made by various chemists of drillings taken from the treated and the untreated iron. These all showed that the principal change caused by the treatment had taken place in the condition of the

carbon; nearly one-half of the combined carbon had been changed to the graphite form. The sulphur was likewise decreased. The shrinkage of the test bars of treated iron was reduced nearly 30 per cent. as compared with the same iron untreated. Various proportions of ferro-manganese (containing about 80 per cent. manganese) were tried, with the final result that the rule was adopted that in each ladle, holding about 600 pounds of iron, needed at that time to pour one full-sized 33-inch car wheel, one pound of powdered ferro-manganese should be used.

It will be observed that manganese acts in two different and opposite ways in cast iron. When alloyed therewith in the cupola in considerable quantity, say 2 per cent. or over, it has a chilling and hardening effect, producing what I have termed a spurious chill of coarse crystalline nature, in contradistinction to the normal chill in a good car wheel, which has a fine and closely woven crystalline structure.

When the alloy called ferro-manganese is added in a ladle of molten car-wheel iron in the small quantity given (1 pound of alloy, containing about 80 per cent. manganese, in 600 pounds of iron), it acts not as an additional contribution of 0.133 per cent. manganese to the metal in the ladle, but simply as a deoxidising and desulphurising flux, cleansing the metal from impurities, softening it and greatly increasing the ductility and strength without injuring the chilled tread of the wheel.

The fact that ferro-manganese was found to be so beneficial in car wheel practice soon led others to exploiting the alloy for general foundry purposes, but the conditions are here entirely different and in most cases this alloy is not only of no benefit, but is actually detrimental to foundry irons. It changes a large portion of the combined carbon in car-wheel (or chilled-roll) iron into the graphitic form, but this remarkable effect cannot take place in ordinary foundry iron which contains usually scarcely more than a trace of combined carbon. The ignorant and improper use of ferro-manganese in general foundries is sure to lead to disappointments.

Silicon for Foundry Use.

Formerly silicon was regarded as a most undesirable element in pig-iron for foundry use, it was thought to produce "blow-holes" and to make unsound castings. In course of time the views of intelligent foundrymen changed with respect to silicon and therewith coincidently came a change in the practice of pig-iron makers as well. No longer was it considered desirable to keep the silicon as low as possible in foundry irons; gradually the average proportion began to creep up.

While experimenting with ferro-manganese added in ladles of car-wheel iron, many years ago, I desired to know the effect upon the metal of other similar alloys and therefore obtained the highest grades of silicon alloys then made, irrespective of cost, the richest contained nearly 20 per cent. silicon. It was a disappointment to find that even when this metal was powdered and pre-heated to redness the influence on the cast iron of the comparatively small amount that could be melted in a ladle of iron without making it dull was almost inappreciable. Similar tests were made with the metal aluminium which cost at that time 33s. per lb.; the results were again disappointing.

These experiments were therefore discontinued until the progress in the art of electro-metallurgy had made it possible to obtain very high-grade alloys of silicon and iron, when they were at once resumed on quite an extensive scale. The result of many tests showed that if an alloy containing approximately 50 per cent. silicon with iron is powdered and added in small quantity to a ladle of foundry iron (not over 1 lb. of the ferro-silicon alloy in 200 lbs. of iron, usually less than this) it melted readily without appreciably reducing the temperature and certain beneficial effects occurred. The metal became both softer and stronger, as may be proved by anyone, in a simple manner, by pouring chill tests and breaking tests from the same iron both treated and untreated. If, however, the molten iron already contains over 2.50 per cent. silicon there is little or no advantage to be obtained by adding this alloy in the ladle.

Ferro-manganese and ferro-silicon possess entirely different functions in cast iron and should not be used indiscriminately or in conjunction. Ferro-manganese is best adapted to the treatment of high-chilling iron for car wheels or chilled rolls, or other chilled castings, where the proportion of combined carbon is large.

Ferro-silicon is best adapted to treatment of foundry iron when from any cause it is hard and brittle, since it possesses the peculiar property of softening and at the same time strengthening such iron. It also enables the founder to vary the grade of iron in individual ladles to suit individual castings or groups of castings. It gives the founder control of his iron after it has been withdrawn from the source of melting, a matter of great importance and value, and it enables him to use cheaper grades of iron.

Finally, I wish to say that neither ferro-manganese nor ferro-silicon can be regarded as universal panaceas. While each in its proper place is of great value, they must, like all other good things, be used intelligently, and if impure adulterated materials are employed they will not only prove to be of no benefit but may be absolutely harmful.

The influence of silicon in softening pig-iron and reducing its chilling property is clearly shown in Fig. 2. Four test pieces were cast in green sand moulds, one face in each being formed with an iron block. The only important difference in composition between the specimens is in the amount of silicon in each. The one on the left contained 0.7 per cent. silicon, the one showing a hole where a drill has been used to obtain borings for analysis contained about 0.8 per cent. silicon. The next contained a trifle over 1 per cent. silicon, and the specimen on the right nearly 2 per cent. silicon. In this case a mere "skin chill" is noticeable on the upper face against the chill block. The remarkable effect of cooling grey iron very suddenly is shown in Fig. 3. Here the moulds are heavy iron chill cups, some are ½-in. section, others 1-in. section, others about ¾-in. round section. All of these specimens are absolutely white iron. Samples of the same iron poured in green sand moulds of about the same size were all perfectly grey in fracture. It will be observed that the white iron crystals always form at right angles to the chilling surface of the moulds, presenting an appearance resembling spokes of a wheel in those of round section, and showing a cross at the nodal lines, or points where the crystals meet, in the specimens of square section. The lines of demarcation are as sharply defined as though scribed with a tool on solid metal, and it is possible, in some cases, to split the specimens lengthwise along these lines. The specific gravity of the grey iron is about 7.2, while that of the white iron is nearly 8. There is, however, an appreciable difference in density of different specimens of white iron just as there is a well-known difference in density of different specimens of grey iron. There is also a marked difference in hardness of white iron crystals.

Open-Hearth Steel Foundry Practice.*

By R. A. Bull.

It is, obviously, impossible to cover the subject more than briefly in a paper such as this, and the writer will confine his remarks as nearly as possible to a cursory treatment of some of those questions of operation which are of particular interest to all foundries making open-hearth steel castings.

The Furnace.

It seems hardly necessary to discuss furnace construction. However, by way of introduction, it will not be amiss to explain for the benefit of founders of other metals than steel, that the two types of open-hearth furnaces—acid and basic—are of the same construction, except for the material used as a bottom. The furnace is of the regenerative type, and has a rectangular shape, with a shallow bath, the fuel being introduced intermittently from each of the two ends or ports. Natural gas, artificial gas, fuel oil, or crude oil provides the fuel, and where oil is used it is atomised by compressed air or by steam, or sometimes by both. Where the furnaces are sufficiently distant from the boilers to condense much of the steam, it is advisable to superheat the latter before it enters the burner. The dryer the air or steam, the better will be the atomisation. It is not a difficult matter to make the furnace superheat its own steam by means of a coil set into the flue, either on the furnace or the stack side of the valve. When ordinary pipe is used for this purpose, valves should be provided at the inlet and outlet of by-passing through the coils, so that the supply line containing the wet steam can be depended on, should the coil burn out.

The roof of the furnace is, of course, arched. There are many differences of opinion concerning this seemingly simple feature, and these arise from the disastrous experiences had with some forms of roof. It is a serious matter to have the roof fall into a charged furnace, and this may be due to defective construction or careless melting. Some roofs are constructed with a sort of downwardly projecting baffle near the ports, to deflect the flame to the bath. This object is attained, I fear, at the expense of cutting-out the roof and causing it to cave. Certain roofs are sprung in both directions, horizontally and transversely. I favour the straight type of roof, that is, one having the same radii, without projections from port to port. Since the furnace is always hotter on the tapping side than on the charging side, due to loss of heat through the charging doors, causing the roof to burn out more quickly near the back wall, it has been found worth while to make the roof at this point 13 in. thick, tapering gradually to 9 in., obtaining this graduation by special silica shapes. Of course, the radii of the inside of the roof are made identical, the difference being on the top or outside. Great care is required to be exercised when lighting a new furnace, in properly loosening the tie rods to allow for graduated and uniform expansion of the roof, to avoid buckling, and so ruining what may have been a perfectly constructed roof.

Features of Construction.

As with the roof, so with the checkers and the stack, is it advisable to provide more generously for the foundry than for the mill, because of the higher working temperature, generally speaking. With a properly designed roof, well constructed, with ample checkers and with a high stack of suitable diameter, given careful manipulation by the melters, and the use of first grade brick throughout, a basic stationary furnace fired with oil should turn out 450 heats for the foundry without more than the usual Saturday or Sunday repairs. The acid stationary furnace should make 600 heats. The gas-fired furnace of either type will not last so long, because it is not possible to so nicely control and direct the flame as with oil. The tilting furnace, naturally, suffers displacement of its brick by rolling it in tapping and its life is very short. It has some advantages over the stationary furnace, but these are not generally regarded as balancing the disadvantages.

Insufficient attention has heretofore been given by most foundrymen to proper atomisation in the oil burner. There are various burners on the market, but those of proper proportions for open-hearth practice are quite few in number. It is, however, only by the use of considerable skill, the acquisition of much experience, and data compiled from carefully conducted tests, that a thoroughly satisfactory burner can be produced, except by mere chance. Probably, one reason for the partial neglect of this feature hitherto has been the difficulty of metering the oil consumed. I believe that less than two years ago it was impossible to secure a meter that would register closer than 12 per cent. of accuracy on fuel oil. Since that time meters have been put on the market guaranteed to register within a permissibly narrow limit.

In connection with the proper atomising of the oil, aside from the mechanical construction of the burner, I believe that a recording thermometer is an excellent device for the oil pipe line. Furnacemen know that fuel or crude oil will not atomise well if either too hot or too cold, and the use of a recording pressure gauge on the oil line and one on the air or steam line are wise investments. By such means experiments will show what temperature and pressures give best results, the readings will show any undesirable fluctuations and the causes for these can be easily remedied. An automatic recorder to register the reversing of the burners, which should take place at approximate intervals of 20 minutes when the furnace is charged, and 30 minutes when empty, prolongs the life of the furnace.

Distinction between Acid and Basic Furnaces.

As to the differences in construction and operation between the acid and the basic furnace, these are more easily disposed of than are the relative advantages of the two practices. The acid bottom is made up of silica sand, while the basic furnace has a bottom of magnesite, or a mixture of magnesite and some basic slag. Additional sand is used for repairing acid bottoms, and magnesite or dolomite for filling up the holes that develop in the basic bottom. The acid furnace is not capable of the reduction of phosphorus and sulphur and, consequently, necessitates the use of pig iron and scrap of low content in these metalloids, for the conversion into steel of high grade. Carbon, silicon and manganese can be reduced easily in the acid furnace, and for the reason that its process is not such a refining one as the basic, its heats can be made more quickly and with less damage to the brickwork.

The basic furnace permits the use of charges containing high phosphorus and moderately high sulphur,

* Presented at the Pittsburg Convention of the American Foundrymen's Association.

for these elements as well as the three reducible in the acid furnace can be worked down to permissible percentages, for first grade steel. Naturally such refinement consumes more time and reduces the number of heats capable of being tapped without repairs to the furnace. This refining process oxidises more metal than does the acid process, causing a higher melting loss, at the same time, charging the molten bath with more gases, which should be practically eliminated before casting. This, of course, calls for the use of proper deoxidisers, concerning the addition of which much has been learned in the past few years. Melting losses in the basic furnace average close to 9 per cent., while those in acid practice are generally claimed not to exceed 6 per cent.

Acid v. Basic Castings.

There is yet considerable difference of opinion as to the relative qualities of acid and basic steel castings, though not a few acid enthusiasts of yesterday are being converted into basic advocates of to-day. Concerning the relative economies of the two processes, it is largely a question of locality and the prices of delivered suitable raw materials. But for superior castings, which must be not only practically homogeneous, but capable of withstanding severe shocks and strains, I champion the basic process, in the face of contrary opinion held by a few eminent metallurgists and sustained by many steel founders in the eastern states. I do not believe that the views held by those who decry the basic furnace because of its difficulty in producing solid castings have been formulated with sufficient knowledge of what has been accomplished by basic steel makers in the past six or seven years. It should always be borne in mind that the superior refining possibilities of the basic furnace are clearly exemplified in the product, and this means much to those whose need is for steel castings containing a minimum of the objectionable elements, and whose purse will not provide for the necessarily high price charged for crucible or electrically-smelted steel castings.

It is, I find, not known to all acid steel founders familiar with basic melting, or to all consumers of steel castings and metallurgists, that there are numerous steel foundries that, for several years, have made it a practice not to pour the last part of the basic heat in castings intended for purposes calling for practically homogeneous steel which will successfully withstand severe shocks and strains. There is an undesired increase of phosphorus and sulphur and a disappointing decrease in manganese and silicon in the last 3 per cent. (approximately) of most heats which carry a normal thickness of basic slag in the ladle. These changes in the analyses are of sufficient degree to cause trouble if such metal be converted into castings such as referred to. It is no uncommon sight to witness the pouring of this inferior metal into ingots to be used only as are crop ends in the mill.

The slag, while serving as a conserver of heat, is principally responsible for the deterioration of the metal lying just beneath it. Experiments have been made, but so far as I know, without complete success, at least in the plant with which the writer is associated, to dispense with the basic slag after tapping the furnace and to substitute for it some other covering which will prevent the chilling of the steel and at the same time not affect the elements in combination. The chief difficulty is found in mechanically removing the slag, which must be done with promptness and thoroughness in the face of decidedly awkward and physically unpleasant conditions.

Patternmaking.

The strength and type of patterns are regulated by the number of castings ordered and the most economical method of producing them.

While dealing with the subject of patterns, I may mention the enormous possibilities of the covering-core pattern. I think its value is greatest in the open-hearth foundry because of the increased difficulty there in preventing scabs and strains with large copes, in casting. The term covering core is really a misnomer, but is used for want of a better one, and at least readily conveys its meaning to foundrymen, to whom the principle is not new. I do not believe anyone, who has not seen for himself with what reduction to foundry cost this use of a copeless mould can be applied, can fully realise its advantages. Naturally, its usefulness is largely confined to designs with large area and open spaces between top members of small or moderate width, all without great variation from the same horizontal plane. I have in mind a certain intricate casting which occupied a floor space over-all of about 120 square feet and weighed only 3,300 pounds. It required one nine-hour shift and five hours of the succeeding shift for eight moulders and five helpers, or equivalent of about 12½ moulders and 7½ helpers to make one mould with cope and drag. The use of the covering core later for this same job permitted the finishing of two moulds (and by the way, much better ones, resulting in a lower piecework rate for chipping the castings) by 12 moulders and six helpers in one nine-hour shift. The piecework cost for labour in making the covering cores for one mould amounted to $1.80. As the cost of core rods, core sand, baking cores, etc., is more than offset by the cost of facing, gaggers, and such materials in the cope, the proportion in favour of the covering core in this case is as two to one. Additional advantages are the elimination of crane service for handling large, unwieldy copes, and the reduction of floor space required on the moulding floor.

Moulds and Cores.

It is, of course, generally known that silica sand of about 97 per cent. purity is the material required for both mould and core, in the case of the former being mechanically mixed with such ingredients as fire clay, molasses, glutrin, water, etc., and in the case of the latter with flour, oil, dry core compounds, etc. Attempts have been made to produce permanent moulds for steel castings, but with very little success, and the field for usefulness here seems to be exceedingly narrow. Unobstructed by corners or angles, cast steel will shrink 5-16 inch per foot and this excessive contraction is the apparently insurmountable barrier before the ready adoption of the mould which will maintain its form in shaking-out.

Up to about 15 years ago it was not believed possible to pour steel in moulds not thoroughly dried and secure castings much less porous than a sponge. As a matter of fact, while a perfectly dry mould will produce a more homogeneous casting than will a green mould, the specific gravity of castings made in green sand, not skin-dried, is found by very careful experiment to be only 4.3 per cent. less than that of steel castings poured in well-baked moulds. There are many cases in which it is quite impossible to properly provide for natural contraction of the cooling casting without resort to green sand for mould or core. In such instances it is manifestly wise to sacrifice the 4 or 5 per cent. of greater density by producing a casting free from shrinkage cracks, some of which are not always observable on the surface. For this reason the use of green sand in steel moulding has its very important applications. Portable oil burners are successfully resorted to as skin dryers for moulds not of convenient size and conformation for thorough oven baking.

Facing and Core Sands.

It is usually found highly economical and eminently satisfactory in every way to use a large percentage of old sand in the facing and core mixtures, many foun-

dries using 50 per cent. of such old sand and some a larger amount, though I know of steel foundries where all of the old sand is consigned to the refuse cars. However, the amount of old sand best to use depends somewhat on the nature of the work to be produced and the amount of fire clay, or other bonding materials necessary, varies as the percentage of old sand varies, since the latter carries clay or other bonds in greater proportion than does the ordinary silica sand as found in nature.

In large foundries an economical method of recovering and handling this black or old sand is by use of a lifting magnet and a grab bucket. The magnet is used to wash the floor, so to speak, and take from it the spills, gates, risers, etc., after which the clamshell bucket follows to pick up the sand a yard or two at a time, and dump it in the storage bin.

Moulding Methods.

Since moulding methods are in their essentials practically the same for all metals, we will only give attention to certain of these methods, peculiar to open-hearth steel foundries. For bottom pouring the mould must be rammed very hard, to avoid straining and breaking out under the pressure of the stream from a large ladle. For the same reason, the flask must be very strong and rigid and the closing of the mould attended with every precaution against run-outs. Because the mould is rammed hard, reducing to a minimum the voids between the globules of sand, ample vents must be suitably placed to permit the escape of gases in pouring, and to satisfy the high shrinkage common to steel, risers or sink-heads of sufficient number and size are provided. These risers are sometimes kept molten for feeding purposes beyond their natural freezing point by the use of stirring rods, charcoal, or thermit.

Cores for Steel Castings.

Because of the severe pressure of the molten metal on the mould, cores of various kinds for the open-hearth steel foundry must be better reinforced with rods than those used for other metals, to avoid springing, and they must be more collapsible than those used in the grey iron foundry, because of the excessive shrinkage. For this purpose, sawdust, coke, cinders, etc., are frequently resorted to, and the dry core compounds are of great benefit, since they enable the preparation of core sand having the requisite bonding strength, at the same time making the core less refractory than does flour.

The use of a cement briquette-testing machine is found most convenient by founders purchasing flour, core compounds and binders in large quantities, as a means of indicating the relative bonding strengths of various compounds and binders.

Providing for sufficiently free shrinkage to avoid rupture is perhaps one of the chief concerns of the modern open-hearth steel founder making large castings or those of intricate design. Enough of interest might be said upon this topic to merit its receiving exclusive treatment in a paper such as this. Location of gate and of risers, pouring temperature, quality of facing and cores, position of flask bars, uniformity of section, nature and relative position of members of casting, runouts, excess of phosphorus and sulphur, over-oxidation; all of these causes, and many others, some not yet fully known, have bearing on this question of contraction.

Casting.

Pouring the metal into moulds justly receives the closest attention. Aside from the waste and attendant unpleasantness due to leaky stoppers, which may be the result of the ladleman's carelessness, the use of defective materials, or the melter's poor judgment, there are found at times scrap castings as a result of clean, but unskilful pouring. Preliminary to tapping the furnace, the ladle is daubed over its brick lining and dried, usually with an oil flame, for about three-quarters of an hour. Then the stopper rod is adjusted, and the lever raised and lowered to see that the nozzle correctly seats the stopper head. If the metal, on entering the ladle, is not hot enough, or if the cold additions are thrown into the ladle too soon, a skull of half-frozen metal will form around the nozzle, preventing the seating of the stopper head and thereby a clean shut-off, until such skull has been melted and freed from the nozzle. If the metal is too hot, the nozzle is frequently first to suffer by cutting-out, and this usually results in a heavy percentage of spills. Should the ladleman permit the stopper to float, or not pinch the stopper tight against the nozzle, a small dribble may appear, and by soon cutting the nozzle, result in a most serious leak. Care must always be exercised not to raise the stopper too high on the first mould, or to close it too soon, after being first opened.

Cleaning the Castings.

Cleaning and chipping steel castings do not offer any novelties to foundry methods in other metals, other than the increased difficulty of removing the tougher metal. The use of pneumatic chipping hammers, cutting-off saws, sand blasts, tumbling barrels, and similar equipment, depends largely on the character of work in each individual shop. The welding of minor defects in open-hearth steel castings when properly performed, is attended with good results and is permitted with reasonable limitations by most of the large consumers. Both the autogenous and the electric method have their respective adherents. My experience has been that the former is more suitable for very light sections, and the arc better for medium or heavy sections in cast steel. In the application of either method, ample heat must be produced for satisfactory work. Good welds cannot be expected with insufficient gas or amperes of current. Pre-heating and after-heating the castings, if of heavy or uniform section, tend to prevent the cooling strains from causing injury. Hammering the weld intermittently while under heat, checks the formation of slag and gives a closer union. On a tensile test one should get an average efficiency of 60 to 65 per cent. of the ultimate strength of the natural cast steel. The elongation and reduction of area are considerably reduced. Analysis shows the metalloids to be almost entirely oxidized, leaving nearly pure iron in the weld, and thus explaining the loss in strength.

Annealing.

The annealing of steel castings must be very carefully done, and attended with constant reference to a reliable pyrometer, to be of the slightest value. The generally accepted correct annealing temperature is about 800 degrees cent. Should the casting be subjected to a temperature appreciably lower or higher than this figure, more damage than benefit results. Hence, the necessity for extreme nicety of operation in annealing castings lacking uniformity of section, to avoid over-heating the lighter members and under-heating the heavier ones. The necessity for annealing at all should be governed largely by the composition of the steel, whose analysis may be such as to make annealing a needless operation for ordinary work.

The loss in bad castings, of course, depends to no small degree on the severity of the inspection, and the class of work common to the shop. However, the ordinary open-hearth steel foundry, producing an average run of work and following a thorough and intelligent inspection system will, if my observations count for anything, have close to 4 per cent. of scrap casting, if working moulders and core-makers during daylight hours only, and 6 per cent. if compelled to employ this labour on both day and night shifts.

Causes of Wasters in Malleable Cast Iron.

By J. Peers.

The production of good, sound malleable-iron castings depends to a great extent on the manipulation of the mixtures employed, and the supposition that undesirable castings are due to the moulding does not always convince the foundryman of an observant nature. The writer wishes, therefore, to point out a few of the errors made daily in the black-heart process. By the Reaumur process most of the defects in question are avoided, by reason of the metal being of different constituents, allowing the gases to escape more freely. When examining the wasters on the scrapheap, the amount of work found to be blistered, or with small holes on the top surface of the castings, is enormous. (The writer is not alluding to blow-holes caused by wet sand, for there is a distinct difference easily detected by the colour; also, when occluded gases separate from the metal during solidification, they do not radiate from the centre as in the forming of crystals.) The best and surest way to avoid these blisters is to pour the moulds with hot metal, but sometimes with the air furnace a dull heat has to be met, and here the art of pouring has an important bearing in preventing this class of wasters. When pouring, the down runner should be kept up well and feeders should be high enough to allow plenty of metal to flow through the mould, as this keeps a passage open; therefore, instead of the gases being trapped under the thin wall that forms spontaneously, it gives them a chance of being carried out into the feeders. A drop of hot metal should also be poured into the feeder.

It is a common practice to stop pouring as soon as the metal gets a reasonable height in the feeder, and then fill the feeder up with hot metal; this no doubt gives the castings a good chance of being well fed, but the gases have not the same chance of escaping that they would have by running the metal well up in the feeder through the mould. For example may be taken a large hub for motors made by the writer. Fig. 1 shows the drag part of the box. It will be seen that as many sprays are cut in as possible, to ensure the castings being run as quickly as possible. In this particular case the sprays had to be in the drag part, but it is good practice to spray in the cope part of box. Fig. 2 shows the top or cope part, with a ridge cut from the down runner. This ridge covers the sprays when both parts are together, and to prevent the loose dirt that is carried down the runner basin entering the mould, the ridge is carried beyond the farthest spray at each end, forming a *cul de sac*. Thus the clean metal is allowed to flow into the mould. The sprays are angled as shown to prevent them from breaking into the casting. This was as difficult a job as any experienced by the writer, as regards preventing the blisters mentioned, owing to the fact that a large boss in the bottom prevented the metal covering the flat plate quickly enough. The blisters always appeared in that part of the casting farthest away from the runners. Fig. 3 gives an idea of the box when closed and where the feeder was placed.

When casting, the writer always pours with metal as hot as possible, to prevent this class of waster. It is questionable if any fixed temperature could be laid down for pouring; an experienced man has not much difficulty in judging when the iron is hot enough for his particular job. The trouble arises when the iron is dull when tapped from the furnace.

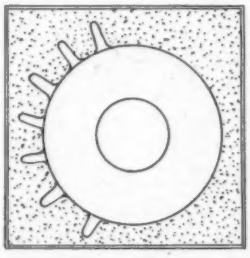


FIG. 1.

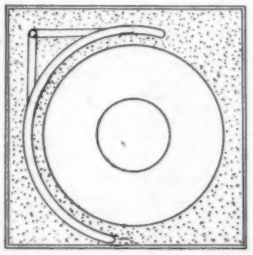


FIG. 2.

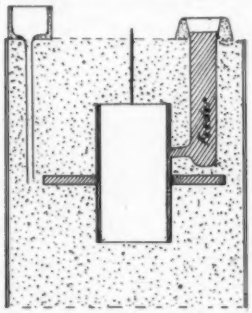


FIG. 3.

Snap Flasks.

This class of box is very much in evidence in the malleable castings trade. It is economical for very light work, but in too many cases work is made in snap flasks which should never be attempted. Curbs and binders many times have to be used, but generally a large number of wasters arise by using this class of box. For example, when the walls of a casting are thick or of any depth, the metal is dribbled into the mould to prevent a burst out or a strain. This dribbling carries all the dirt from runners and metal into the mould, spinners to keep out the dirt being useless. If a proper box was used, the runners could be kept full, thus preventing the loose dirt caused by the wash of the metal from entering the mould. Another thing against this class of box is the unequal weighting, which often causes an overlap, when half of the pattern is in drag and half in the cope.

Feeders and Chills.

Malleable cast iron (black-heart) has such a narrow range of fluidity, that the feeding rod is absolutely

excluded; therefore the liquid shrinkage must be met by feeders and chills, and it is on the questions of where and how to run a casting, where a feeder is required, whether a chill should be used, and the size of the chill that success largely depends.

The methods adopted by moulders, to prevent wasters and to get their castings to run up sharp are varied and novel. One particular job could not be tied very well in a place where a crack or ripped place occurred, by uneven contraction. After several attempts success was attained by means of a chill, made to the curvature of the underside of pattern with very good silica sand on the top side of the pattern. The chill and sand absorbed the heat in this part of the casting with good results. Raw red sand placed on the part that is difficult to run, will allow of the castings being run up sharp.

Furnaces.

The silicon and carbon play very important parts in the castings when the annealing shop is reached. Work of half-an-inch sectional thickness may have a composition approximately, carbon, 3 per cent., silicon 0.8 per cent., sulphur, 0.06 per cent., manganese, 0.6 per cent., and phosphorus — per cent. If the charge had been worked out to come out to the above, and work of a thicker section was on hand, by the addition of steel scrap the carbon could be lowered, and a relative increase in silicon obtained. This facilitates the breaking down of the carbides in less time during annealing.

Another problem of importance is the variations of the temperature of the furnace before charging. If the furnace is heated to a high temperature, the loss in silicon is very little, but if at a low temperature when charged, the silicon is oxidised too much, as a low temperature favours the oxidisation of silicon. It is, therefore, obvious that by careful watching of the furnace it is possible to reduce the silicon, or to keep it within reasonable limits of the charge put on. This shows clearly how easy it is to make a bad heat, even if the best of material is used, when by good manipulation an inferior material will give better results.

Sulphite Lye for Coremaking.

In our last issue we published a note regarding the use of sulphite lye for core making. We now learn from Messrs. Abbott, Drescher & Company, of 20 & 21, Queenhithe, London, E.C., that the use of this material is patented and that they are the sole representatives for the supply to the English market. The article is here sold under the name of "Sulphite Extract," and is, we understand, being used by some of the largest steel founders in this country.

To prepare new sand for core-making, when employing this sulphite extract, about 14 to 18 lbs. of the material are required for 1 ton of sand. The extract is dissolved in a sufficient quantity of water, which must be able to dissolve it entirely, otherwise rain water, or cold boiled water should be used. The sand is spread out on the floor and sprinkled with the solution, the whole of the sand being saturated, after which it should be passed through a mixing machine if available. Then the sand must be left a short time—say 10 to 20 minutes. After this operation it is prepared as usual. Cores thus prepared become very porous and have a great resistance. If very complicated cores are made, 2 lbs. of pulverised resin should be added to each quantity. Bents and iron inlayers are seldom required except when the cores are very large. The cores have to be baked gradually, and not too much.

To renovate old foundry sand, the old and burned sand must be screened and the lumpy pieces crushed by edge rollers or a crushing machine. For about 1 ton of this sand about 4 to 5 lbs. of sulphite extract dissolved in water are sufficient. The sand is spread on the floor, sprinkled with the solution, well mixed, and afterwards prepared with coal dust, etc., as usual. The quantity to be used with core sand depends on the binding capacity of the material.

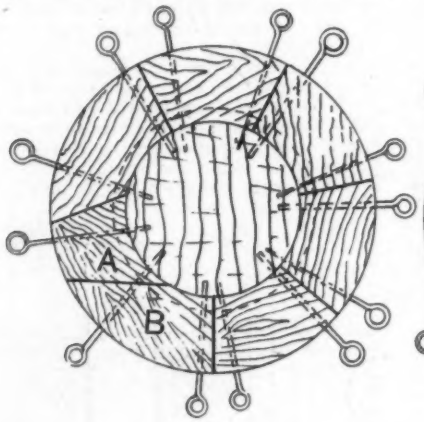


FIG. 1.

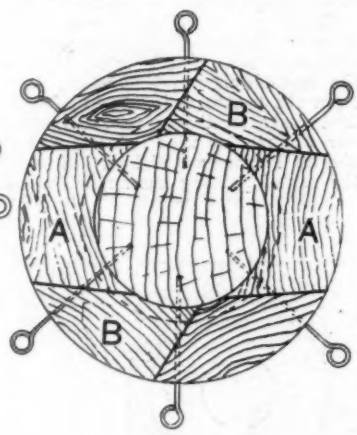


FIG. 2.

THE CUTTING OF SECTIONED FLANGES.

The Cutting of Sectioned Flanges.

By J. M.

Occasionally it is necessary to cut flanges for pump patterns and bedplates, to allow for the patterns to be bedded in the floor. Fig. 1 shows an example of a round flange on a branch of a pump body. It will be observed that the way in which this is cut, allows for each section to spring independently of its neighbour, and with the result that the casting is unsightly, due to the irregular and stepped appearance of the sections.

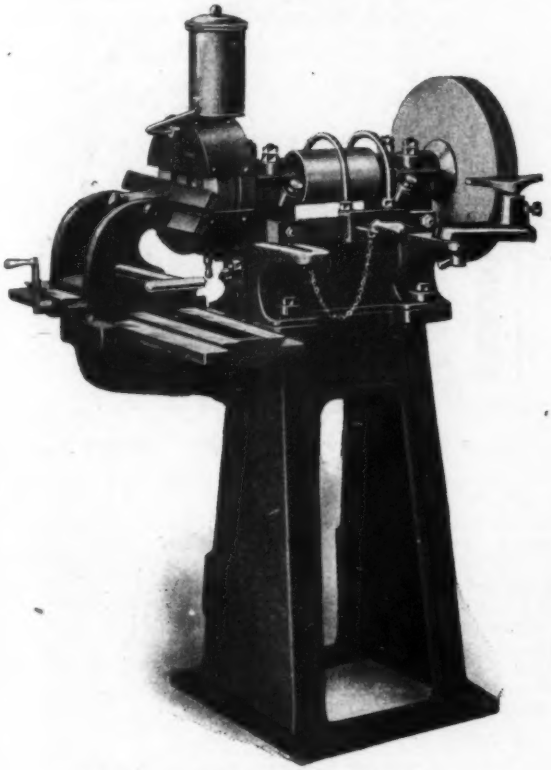
Fig. 2 shows a better method. The skewers are made to pierce both sections and thus form a better support, with less number of skewers used. This same principle is followed in the moulding of ribbed sections of bedplates, where the methods of moulding demand these being drawn in. The sketch clearly explains itself, the piece A being first drawn, and then B.

Foundry Plant and Equipment.

Plane-Iron Grinding Machine.

The importance to the pattern-makers' shop of a suitable apparatus for grinding plane irons, particularly those for planing machines, where accuracy is the great essential, is too well-known to require emphasising. Herewith is shown the "Perfect" grinder, a machine well adapted for such work, which is manufactured by the London Emery Works Company, Park, Tottenham, London, N.

The attachment shown on left of the machine is



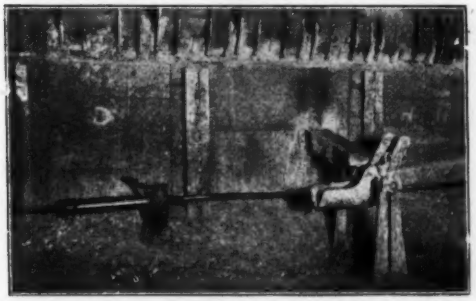
THE "PERFECT" DOUBLE PLANE-IRON GRINDING MACHINE.

suitable for pieces up to 16 in. long. A suitable holder is provided for carrying the work, which is passed across the face of the wheel by means of the handle shown, the feed being regulated by a screw handle. The machine is usually supplied for dry grinding on this side, although we illustrate it for wet use with hood and drop can. On the right side of the machine is a rest and wheel 14 in. by 2 in. for general dry grinding, but this can also be arranged for wet grinding with hood, drop can and suitable rest.

The bearings of the machine are the company's improved self-oiling and dust-tight ring type, but ordinary plain bearings can be fitted instead, if desired. The stand can have a self-contained countershaft, in which case there is a decided advantage compared with a separate countershaft if it is required to drive the machine from below. The countershafts comprise fast and loose pulleys for driving from the main shaft with belt shifting gear, and a single fast pulley for driving the machine spindle.

A Continuous Pouring Spout for Open-Hearth Furnaces.

A device to insure continuous pouring of metal, particularly from reverberatory and open-hearth furnaces, is illustrated herewith, the object being to overcome the trouble involved in intermittent pouring from such furnaces. By its use the melt from open-hearth steel furnaces can be drawn into a number of ladles without stopping the flow, thus doing away with the necessity for employing very large ladles and slow and heavy cranes. Apart from the saving in time, temperature and metal, an increase in the size of the furnace is possible, which enables it and the labour and the machinery employed in connection with it to be used at the greatest efficiency. A saving in the amount of metal used and also in cleaning the floors is effected,



SPOUT FOR CONTINUOUS POURING FROM A REVERBERATORY FURNACE.

since there is practically no drip, and with the reverberatory furnaces it is possible to draw metal from several spouts simultaneously, thus enabling straight or parallel-floor foundries to be advantageously served by mechanical handling appliances.

The continuous pouring device consists of an additional tilting spout located at the end of the regular one and moved backwards and forwards by a lever and rocker arm operated by an air cylinder. The illustration shows how the respective channels of the spout move automatically out of the way of the filled ladle, permitting it to be lifted by an overhead traveller or crane, and permitting also an empty ladle to be placed in position for filling. The air for operating the cylinder passes through a two-way valve which is connected to the cylinder actuating the mechanism of the tilting spout. In this way the air is admitted to the ends of the cylinder alternately, and the metal is poured

first from one leg of each spout and then from the other. The device has been developed by Mr. G. K. Hooper and is being manufactured by the Hooper-Falkenau Engineering Company, New York City, U.S.A.

Portable Metal Melting Furnaces.

The Schwartz melting furnace has by now become familiar to many foundrymen, but a more recent development of the apparatus, the portable Schwartz furnace, illustrated herewith, is not so well known. It is in its essentials the same as the earlier furnace, but the air and oil (or gas) system is so built that it can be uncoupled in 15 seconds, the furnace picked up by the crane and poured from, direct into the moulds. This means that there is no necessity for heating the

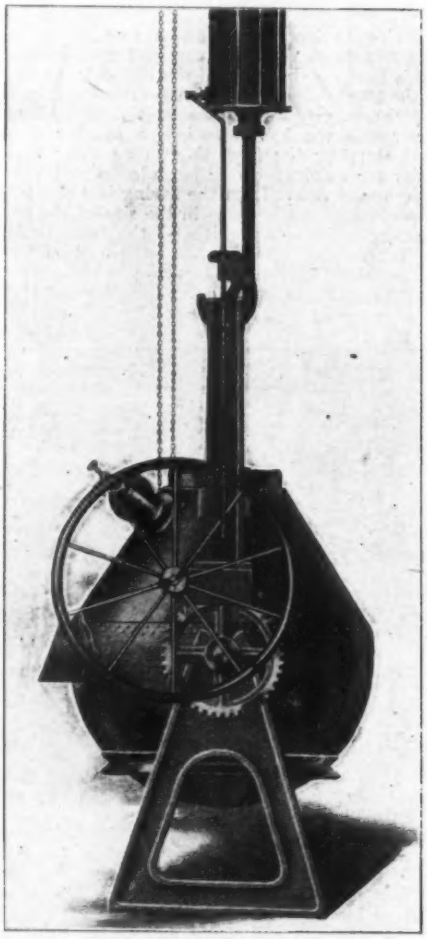


FIG. 1.—END VIEW OF PORTABLE SCHWARTZ FURNACE.

metal to a higher point than that required for pouring, as there is no heat lost by transferring to ladles.

In operating the furnace the ports are sealed when the melt is completed. A twist of the wrist uncouples the air and oil pipes, the crane picks up the cauldron, carries it to mould after mould, and in this way one man does all the pouring. Whether its load of molten iron be used up in a few minutes in pouring a few large moulds, or considerable time be employed in pouring a number of small castings, the metal is

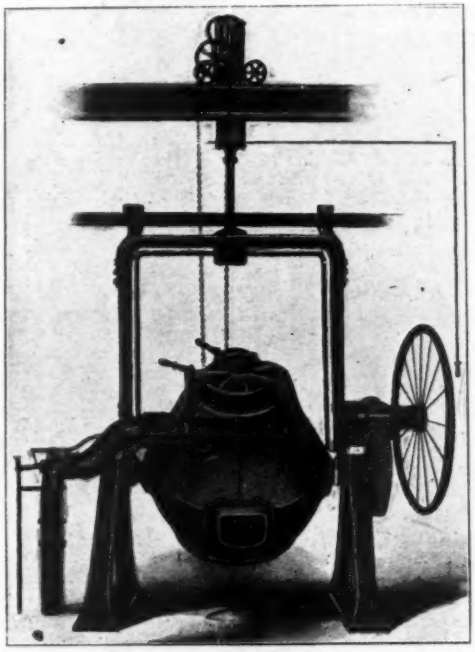


FIG. 2.—FRONT VIEW OF PORTABLE SCHWARTZ FURNACE.

always held fluid by the thick white-hot fire-brick lining, as the cauldron is tightly sealed.

This furnace is suitable for making steel castings, semi-steel castings, malleable-iron castings, grey iron castings, copper, brass and aluminium castings, from the smallest to the largest, the sizes of the furnace ranging from 500 lbs. up to 4 tons capacity. The makers are the Hawley Down Draft Furnace Company, Chicago, U.S.A.

The "Ulster" H.P. Fans.

The accompanying illustration represents an "Ulster" H.P. blower coupled direct to an electric motor. These fans are designed for use where high pressures are required with small volumes of air such as are necessary with cupolas or gas plants, up to 20 or 25 inches water pressure.

The fans are of specially strong construction, the casings being of cast iron and the shafts and wheels of steel. They are designed and manufactured by the well-known fan-specialists, Messrs. Musgrave & Company, Limited, Belfast and London. This class of fan is also made with pulleys for belt drive or prepared for coupling direct to steam turbines.

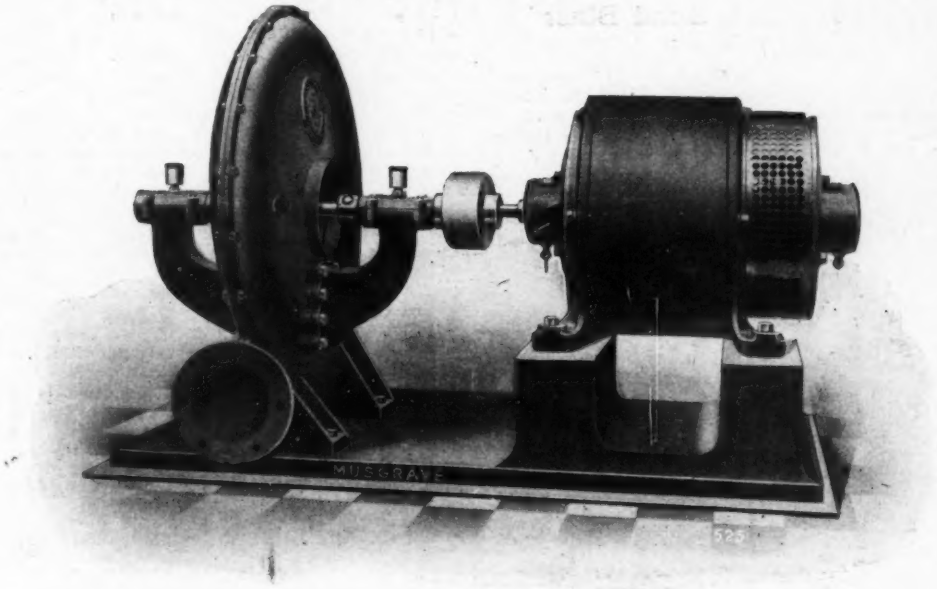
Pattern Drawing Apparatus.

The portable pattern-drawing machine made by the Osborn Manufacturing Company, Cleveland, Ohio, U.S.A., which is shown herewith, has been designed for the drawing of patterns on large, heavy work, especially such as is rammed on jolt machines. This device makes it possible to draw the mould on the floor where it is to be poured and to secure a smooth, even draw, whether the flask rests level or not.

The device consists of a frame which fits over the pattern plate and is supported on four posts resting on the rim of the flask. The accompanying illustrations show the pattern attached to half of an iron flask, but ordinarily the pattern is attached to a plain plate or matchboard. The matchboard is placed in the jolt ramming machine, the flask set upon it and the sand shovelled in and rammed in the usual manner. The sand is then struck off, the bottom board clamped on and the flask rolled over by a roll-over tackle or rigging and swung to the floor. In large work the crane then raises the pattern-drawing device and sets it over the pattern plate on the edge of the flask, the four pins passing through the notches in the edge of the plate. Fig. 1 shows the device being lowered.

A set of short cranks are connected to the pattern plate by links and are operated by long levers. In Fig. 2 these levers are thrown so that they cross each other, the device being set on the mould preparatory to drawing the pattern. In Fig. 3 the levers are thrown out, drawing the links into their uppermost position and raising the pattern plate from the face of the flask. When the pattern is drawn the crane raises the whole device from the mould, the pattern plate is released and returned to the moulding machine.

Five sizes of the apparatus are made, ranging from



ULSTER H.P. BLOWER DIRECT COUPLED TO ELECTRIC MOTOR WITH COMBINED BEDPLATE.

FIG. 1.—LOWERING FLASK ON TO PATTERN.

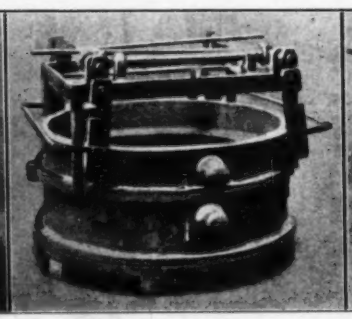


FIG. 2.—READY TO DRAW PATTERN.

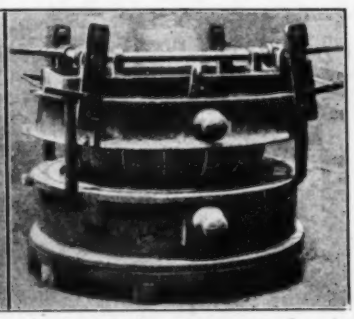


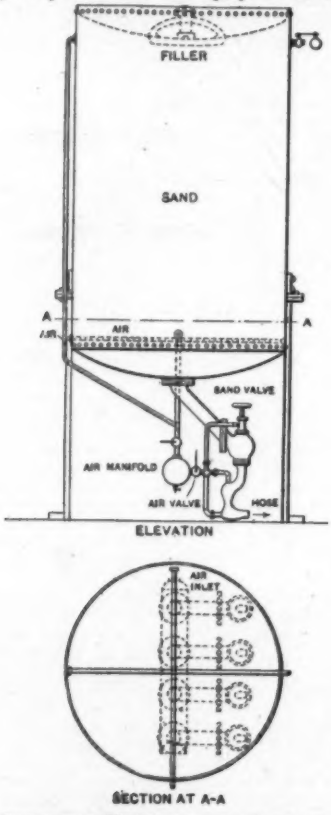
FIG. 3.—PATTERN DRAWN FROM MOULD.

THE OSBORN PATTERN-DRAWING MACHINE.

18 in. square to 47 by 72 in. with maximum pattern draw of 6, 8, 10, 12, and 15 in. for the various sizes. In the case illustrated the flask and pattern weighed 1,200 lbs., but they were easily drawn by two men with this machine without the aid of a crane or hoist.

The Drucklieb Sand Blast Apparatus.

The sand-blast apparatus shown herewith, known as the "Drucklieb" multiple injector sand-blast, is designed more especially for use in foundries having a large output of pieces of a similar character. A vertical cylindrical tank made of riveted boiler steel and capable of withstanding a working pressure of 80 lbs. per square inch is employed for storing the



SECTIONAL VIEWS OF THE DRUCKLIEB MULTIPLE INJECTOR SAND BLAST APPARATUS.

sand. In the upper end of the tank there is a large sand inlet closed by a manhole cover. One, two, three or four outlets, with pipes to lead the sand to a special form of injector sand-blast apparatus, are attached to the bottom of the tank by flanged connections. The sand is thoroughly mixed with the air in the sand-blast apparatus and discharged through a line of rubber hose equipped with a nozzle holder. The flow of sand is regulated by a sand valve, one of the special features of which is a central air jet that imparts a greater evenness and regularity to the flow of the sand than is obtained by gravity alone, the current of air forming a low vacuum underneath the valve and effecting this.

The supply of compressed air is piped from the air receiver near the compressor through a riveted steel manifold, which is placed horizontally under the sand tank, and also serves as an air separator. The supply for each outlet is controlled by a single lever-handle, quick-opening gate valve, the air being piped to the sand valve and the mixing and the forcing openings. The flow of sand through each outlet can thus be started, regulated and stopped independently of the others without affecting their action in any way. The necessary draining facilities are also provided for the manifold.

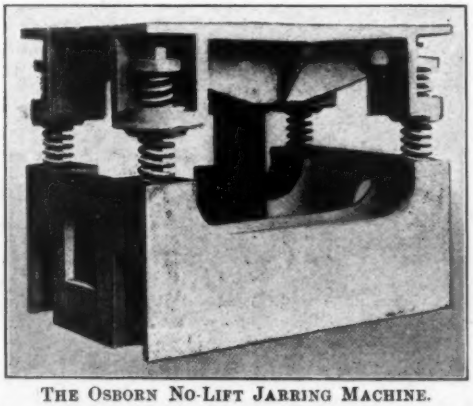
Air is piped from a separate connection controlled by one valve to the upper part of the tank to balance the pressure, and also to two perforated tubes placed at right angles near the bottom of the sand tank. Small jets of air delivered through these openings agitate the sand and further facilitate its flow. The mixed air and sand currents are delivered through a length of rubber hose from each main outlet to the nozzle holder in the customary way. Where required further subdivision can be made by employing Y-fittings.

If it is desired to carry on the sand-blasting work continuously, this can be done by superposing a second tank with the necessary valves and piping upon the regular sand tank. These multiple sand blasts are made with capacities of 2,000, 4,000, 6,000 and 16,000 lbs. of sand, and with one, two, three or four outlets, by Mr. J. M. Betton, 179, Washington Street, New York City, U.S.A.

The Osborn No-Lift Jarring Machine.

Herewith is shown the Osborn no-lift jarring machine, designed for use in the core room or on upper floors. No foundation is required for the machine, and as the blow is upward it is claimed that there is no shock to the floor, the force being entirely absorbed in packing the sand.

The machine consists of an ordinary moulding machine table, beneath which is a cylinder in which works a piston, which strikes a blow on the under



THE OSBORN NO-LIFT JARRING MACHINE.

side of the table. The table is supported on springs, and is ribbed so that the force of the blow is distributed to all parts of the mould, and draws the sand down uniformly to the pattern or into the core box. The machine requires only a ¼-in. inlet for air, and has a 4-in. cylinder and a specially designed self-contained valve. The table has a working surface of 24 by 36 in., and the machine will jar moulds up to 1,000 lbs. in weight. The makers are the Osborn Manufacturing Company, Cleveland, Ohio, U.S.A.

Inventions.

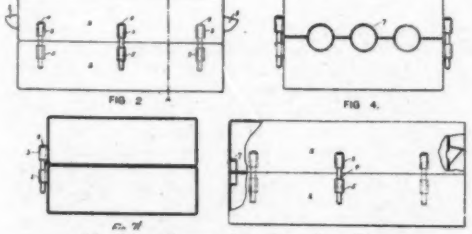
Applications for Patents.

An asterisk indicates that a complete specification accompanies the application. When inventions are communicated the names of the communicators are in brackets.

11,900*Process for casting steel in several layers. (Akt.-Ges. der Briansker Schienen-Eisenhüttenwerke und Maschinenfabriken, Russia.) O. Imray.
12,275. Casting ingots of steel, etc., and moulds therefor. H. C. Law.
12,429. Processes of producing aluminium and its alloys. H. F. D. Schwahn.
12,437. Casting metal. W. Stoddart.
12,998.*Moulding and casting radiators, sectional boilers, etc. F. J. Nilsson.
13,016.Muffle furnaces. J. R. C. August.
13,393. Improved pipe-moulding machine. P. Campbell and G. E. Tucker.
13,678.*Furnace for melting alloys of aluminium and other alloys. A. F. Cothias.
13,679.*Furnace for the preliminary heating of furnace moulds. A. F. Cothias.
13,680.*Apparatus for conveying furnace moulds from their heating furnace to the pouring stages. A. F. Cothias.

Abstracts of British Patent Specifications accepted.

3,659 (1911). *Moulding Boxes for Foundry Use.* W. H. Lumsden, 130, Blenheim Place, Aberdeen, N.B.—Figure 1 is a side elevation of a two-part moulding box constructed in accordance with this invention; Figure 2 is a section on the plane A—A, Figure 1, illustrating the form of the flanges; Figure 3 is an end elevation, and Figure 4 a front elevation, illustrating how casting holes may be constructed. The folded blanks are brought together and then welded to form box-like casings 2. If the box parts are to be used as a two-part moulding box, as shown, one box part is provided

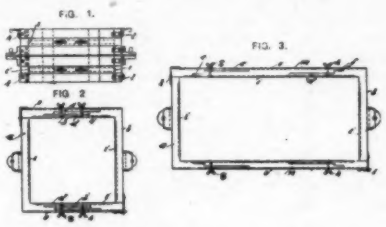


Moulding-boxes for Foundry Use.

with snugs 3 welded on to the sides, and provided with tapered pins 4 fitted in corresponding orifices therein. The other box part is provided with snugs 5 for the reception of these pins 4. Boxes provided with casting holes are constructed as shown in Figures 3 and 4. The casting holes 6 are formed by punching semi-circular openings in adjacent ends of two box parts; the flanges on each part being made continuous around these openings by welding on around the openings metal blanks 7. Handles 8 may be secured to the box parts by welding as shown. To allow of the box being placed vertically, if desired, the longitudinal sides of the box parts may be extended beyond the handle.

12,343 (1910). *Carburisation of Iron and Steel.* S. S. Eveland, 812, Montgomery Avenue, Bryn Mawr, U.S.A.—The fibrous remnant left after the extraction of sugar from beet is used as the carburising agent. This refuse is readily obtainable in large quantities, and consists of a fibrous mass which may be dried. This material is employed either with or without comminution, and either simply dried or more or less charred, bringing it into proximity to the surface of the metal which is to be carburised and subjecting both to the required degree of heat within a substantially closed receptacle. As the result the carburisation obtained is more uniform and of greater depth.

14,806 (1910). *Moulding Boxes.* E. J. H. Plötz, Merseburger Strasse 33, Halle a/S, Germany.—Figs. 1 and 2 show a small moulding box in elevation and plan respectively, while Fig. 3 shows the parts assembled so as to form a large moulding box. The device consists of an upper and a lower frame, having the longer sides divided into two or more pieces, the side walls *a* and *b* being also divided if necessary. The arms *c*, *d* are cut away in the manner indicated in Figs. 2 and 3, *i.e.*, provided with a number of rectangular cut-out portions, the smaller cut-outs *e* and *f* being adapted to receive the



Moulding Box, by Plötz.

ends of the arms *d* and *c* as the case may be. When the parts are assembled, as shown in Fig. 2, a suitable insertion *j* may be effected in the space formed between the arms *c* and *d*, the parts being secured together by suitable screws, *g*, *h*. If the moulding box is to be made larger, as in Fig. 3, then the insertions *j* are replaced by the side pieces *m* and *n*. The latter can, of course, be of any desired length. The frames are provided with the usual sand grooves *i*, and in order that they can be removed from the mould, they are provided at one corner with a hinge *k*, and at the diametrically opposite corner with a locking arrangement *l*.

25,741 (1910). *Manufacture of Steel.* F. Kohlhaas, 32, Zimmermannstrasse, Düsseldorf, Germany.—It is known that steel containing 10 per cent. of manganese has a very small magnetic permeability. The richness in manganese, however, has the consequence that steel of this kind cannot be worked by means of tools. Moreover the richness in manganese has the effect that by strongly increasing the limit of elasticity the tenacity of this steel is very unfavourably affected. In the experiments made to produce a non-magnetisable steel rich in manganese, it is of importance to remove the above drawbacks (impossibility of working and slight tenacity), and it has now been found that with the aid of titanium a steel can be produced which can be easily worked and whose limit of elasticity under conditions of high tensile strain does not exceed about 47 per cent. of the figure found for the breaking strain, this corresponding to a high tenacity of the steel. At the same time the magnetic permeability of the steel is lower than that of pure nickel and cobalt. These properties provide a wide range of usefulness of the steel for many different purposes where non-magnetic or non-magnetisable material must be used, as is for instance the case in shipbuilding. The steel is characterised by the following composition:—about 9.8—10.3 per cent. manganese, 0.9—1 per cent. carbon, 0.2—1.4 per cent. titanium, 0.4—0.7 per cent. silicon, maximum, 0.03 per cent. sulphur, 0.015 per cent. phosphorus, and can be produced both as crucible steel and in the Martin-furnace, soft ingot-iron poor in carbon and ferro-manganese containing 80—85 per cent. of manganese, being as a rule employed.

"F.T.J." Bookshelf.

Elementary Foundry Practice.

By Wm. Allyn Richards B.S. in M.E. London: The Macmillan Company.

The author of this text book for the use of students in colleges and secondary schools is the instructor in forge and foundry practice in the University High School and the University of Chicago, and should, therefore, be in a good position to know the requirements of early students. Strictly elementary works on foundry practice—such, for example, as would be readily comprehensible by boys at secondary schools—are, it must be admitted, not abundant; for such a work must be couched in language as non-technical as possible, while still retaining the correct moulding-floor terminology and designations. This the author appears to have done, and the result is a simple and clear exposition of the principles and essentials of foundry practice. Not only are gray-iron castings treated, but a brief chapter deals with chilled and malleable castings, while a further one takes the subject of brass moulding. The contents are, of course, not sufficiently advanced to be of much use to foundrymen, but the book will be found very useful in schools and elementary technical classes.

Query.

Chilled Truck Wheel Bosses.

We are experiencing great difficulty in getting some of our castings properly chilled. They consist of bosses or centres for traction engine truck wheels. We use iron chills, and make the castings from machine scrap, to which is added "Frodair" pig and "Norrfield" pig. We have also tried "Carron No. 1" pig, but without success. Occasionally we get one chilled, but the majority of the castings are hardly chilled at all.—"W. A. S."

Reply.—Our correspondents do not give complete details of their mixtures, but presumably machine scrap forms the major percentage, to which has been added some "Frodair" and "Norrfield" pigs. We do not think that either of these pigs are reputed to be chilling irons, and consequently even a superficial chill could not legitimately be expected. "Carron No. 1" pig cannot remedy the matter nor adjust the mixture reliably in any way. It is very evident that the inability to produce a regular chill is due to the fact that no really chilling iron has been introduced. It is imperative that some should be used, and also that hard quality scrap of a suitable description be included. There must be a judicious selection and mixing of pig to ensure satisfactory results, to provide for the maximum strength as well as a hard-wearing surface. Difficulty is frequently experienced by founders who expect to get desired results without having given due consideration to their choice of pig and mixing, and in this connection when working for a chill we would point out the advisability of always making a preliminary test of the mixture on a cast-iron plate prior to any large cast. This will save much time and furnish the founder with a really valuable knowledge as to the possibilities of his metal. Since our correspondents are now using brands of the Frodair Iron & Steel Company, they might put their case before this firm, who would probably advise them as to suitable and approved mixtures for chilled work.—Editor, "F.T.J."

Trade Talk.

Messrs. J. Parkinson & Son are extending their Canal Iron Works at Shipley.

The Chesterfield Tube Company, Limited, are making extensions to their works at Chesterfield.

Wailes, Dove & Company, Limited, 23, Royal Exchange Square, Glasgow, are removing to 145, Queen Street, Glasgow.

Messrs. D. & A. Home Morton, engineers, 130, Bath Street, Glasgow, have removed to 153, St. Vincent Street, Glasgow.

The Efandem Company, Limited, engineers, of Birmingham, are about to erect new works in the Fallings Park district of Wolverhampton.

The name of the Patent Indented Steel Bar Company, Limited, has been altered to the Indented Bar and Concrete Engineering Company, Limited.

Messrs. Ollendorff & Clarkson, 163, Hope Street, Glasgow, have been appointed sole representatives in Scotland for the British Humboldt Engineering Works.

Mr. H. J. Skelton, of Royal London House, Finsbury Square, London, E.C., the London agent of the Lilleshall Company, Limited, Priors Lee Hall, Shifnall, Salop, has resigned.

The Berndorf Metal Works, Arthur Krupp, have now removed their headquarters at 19, Baker Street, London, W., to more central premises at 231, Regent Street, London, W.

Messrs. J. Petford and J. H. Walker, carrying on business as brassfounders, at 32, Floodgate Street, Birmingham, under the style of Petford & Pountney, have dissolved partnership.

Mr. J. W. Bainbridge, 2, Fen Court, Fenchurch Street, London, E.C., has been appointed London agent for Moses Mellor & Sons, Limited, Arkwright Street, Nottingham, for iron castings.

Messrs. Pyne, Hughman & Company, 4, Lyons Range, Calcutta, have been appointed sole agents in British India for Messrs. Berry, Skinner & Company, engineers, Suffolk Works, Birmingham.

Thermit, Limited, 27, Martin's Lane, Cannon Street, London, E.C., have appointed Messrs. T. H. Watson & Company, iron and steel merchants, etc., of The White Building, Sheffield, sole selling agents in that district.

Mr. Justice Neville, in the London Winding-up Court, on May 30, made the usual compulsory order against J. G. Childs & Company, Limited, on the petition of the Earl of Dudley's Round Oak Works, Limited.

Messrs. Ekman & Company, of Gothenburg, have appointed Mr. William McLean, Stirling Chambers, Campo Lane, Sheffield, as their representative for their Swedish iron and steel business in the United Kingdom.

William Bayliss, Limited, Islington Tube Works, Birmingham, have appointed Messrs. Johanning & Company, Queen Insurance Buildings, 10, Dale Street, Liverpool, as their sole agents for Birkenhead and Liverpool and district.

Mr. Henry Ede, Rectory Chambers, Norfolk Row, Sheffield, has been appointed sole agent for the Humboldt Engineering Works, of Cologne, and also for Eisen-und Stahlwerk "Mark," of Wengern-Ruhr, for the North Midlands district.

The offices of the Machine-Tool and Engineering Association, Limited, which was recently formed for the protection at exhibitions of the machine-tool and engineering exhibitors' interests, are at 104, High Holborn, London, W.C.

At a recent meeting of the shareholders of the Middlesex Foundry & Metal Company, Limited, it was decided to wind up the company voluntarily, with Mr. A. B. Kann, of Finsbury Court, Finsbury Pavement, London, E.C., as liquidator.

Subscriptions have been invited by the Steel Company of Canada, Limited, for one million dollars 7 per cent. cumulative preferred stock (being part of 6,496,300 (dollars issued) at the price of £19 6s. 10d. per 100 dollars share, being approximately 94 per cent.

Personal.

SIR ROBERT HADFIELD landed at Liverpool on June 6, after an absence from this country of over 18 months.

THE late Mr. W. Timmins, of Timmins & Sons, Limited, ironfounders, Runcorn, left estate valued at £3,529 gross.

MR. S. FURNESS, of Furness, Withy & Company, Limited, has joined the Board of the Diesel Engine Company, Limited.

THE gross value of the estate of the late Mr. W. H. Pratt, retired ironfounder, of Pontllanfraith, is £2,475, of which £1,949 is net personalty.

THE late Colonel John Pennycuick, last president of the Royal Indian Engineering College at Coopers Hill, left estate valued at £4,777 gross.

THE late Mr. W. E. Walker, of Walker Bros., Limited, left estate valued at £15,656 15s. 8d. gross, with net personalty £14,460 4s. 7d.

MR. MALCOLM BLAIR has been appointed general manager of the works of Head, Wrightson & Company, Limited, of Thornaby and Stockton-on-Tees.

THE gross value of the estate of the late Mr. W. Hewitt, connected with Brett's Stamping Company, Limited, is £4,498, including net personalty £2,889.

THE late Mr. J. Pryor, a director of the Redruth Foundry Company, Limited, Redruth, Cornwall, left estate of the gross value of £13,063, with net personalty £8,038.

PROFESSOR GOODMAN has been re-elected president of the Leeds University Engineering Society, while Mr. J. Hartley Wicksteed has been added to the list of vice-presidents.

MR. G. MURE RITCHIE, the chairman of the Millom & Askam Hematite Iron Company, Limited, has recently joined the board of directors of the Blaenavon Company, Limited.

MR. R. RATSEY BEVIS, managing director of Cammell, Laird & Company, Limited, who has been on a business trip to the United States and Canada, has now returned to this country.

MR. T. FREESTON, engaged in the foundry at Messrs. John Brown & Company's Atlas Works, Sheffield, has been appointed works manager to the Warrington Steel Foundry, Limited.

MR. W. SHEFFIELD, who has been manager for the past eight years of Messrs. J. Shipman & Company's Attercliffe Steel Works and Wire Mills, Sheffield, has severed his connection with that firm.

WHILE riding on June 7, Professor Capper, of the governing body of the Imperial College of Science and Technology, and Professor of Engineering of the University of London, was thrown, and seriously injured.

MR. JESSE COLLINGS, M.P., and the Hon. William Kenrick are to have the honorary freedom of the city of Birmingham conferred upon them. Mr. Kenrick is a director of Archibald Kenrick & Sons, Limited, iron founders, of West Bromwich.

MR. J. GWYNNE has resigned his position as managing director of Gwynnes, Limited, but will retain the chairmanship and hold the office of consultant to the company. Mr. Nevile Gwynne will act as managing director, and Mr. James M. Dewar has been elected to a seat on the board.

MR. C. MACKROW has resigned his position as a director of the Thames Ironworks, Shipbuilding and Engineering Company, Limited, but still retains his official connection with the works. Captain J. Douglas Walker and Mr. A. E. Seaton have been elected to the board, and have both accepted professional service with the company.

THE employés of the steel works department of Parkhead Forge, Glasgow (William Beardmore & Company, Limited), entertained Mr. George Ritchie, steel works manager, to dinner, on May 27, on the occasion of his leaving Parkhead for Middlesbrough, where he is to take up the duties of general works manager to Bolckow, Vaughan & Company, Limited. Mr. Ritchie was also the recipient of a presentation.

A BANQUET was given on June 30, at the Savoy Hotel, by the Duke of Devonshire, President of the Iron and Steel Institute, and a representative committee of the iron and steel makers of this country, to the United States delegates to the Brussels Conference in July. These delegates included Messrs. E. Gary, chairman of the Steel Corporation and president of the American Iron and Steel Institute; P. Stackhouse (Cambria Steel); E. C. Felton (Pennsylvania Steel); E. A. S. Clarke (Lackawanna Steel); T. J. Drummond (Algoma Steel); W. L. King (Jones & Laughlin); J. A. Campbell (Youngstown Sheet and Tube); J. G. Butler, jun. (American Bessemer Pig-iron Association); J. T. McCleary (secretary of the American Iron and Steel Institute); J. A. Farrell (President of the Steel Corporation); and W. A. Rogers (Rogers, Brown).

Deaths.

MR. E. GILLOW, of Dobson & Barlow, Limited, engineers, Bolton, died recently, aged seventy-four years.

MR. W. J. JENKINS, head of the engineering firm of W. J. Jenkins & Company, Limited, Retford, died suddenly on May 29.

MR. P. YORKSTONE, who, for many years, carried on the business of an ironfounder in Blue Street, Boston, died recently at the age of 65.

THE death is announced of Mr. G. Prime, of Messrs. F. & T. Prime, ironfounders, of the Alma Street Foundry, Aston, Birmingham.

MR. A. GROVE, for over twenty-eight years with Bailey, Pegg & Company, Limited, ironfounders, of Brettel Lane, Brierley Hill, died recently, at the age of 61.

THE death took place at his residence, The Grange, Coventry, on June 10, of Mr. W. H. Herbert, a director of Alfred Herbert, Limited. He was sixty years of age.

THE death has occurred of Mr. J. Chisman, an old and respected tradesman of Durham. Mr. Chisman, who was 65 years of age, carried on the business of an ironfounder at the Elvet Bridge Ironworks.

MR. T. REID, who founded the engineering firm of Thomas Reid & Sons, Paisley, died suddenly last month at his residence at Ardnadam, Firth of Clyde, aged 87 years. He retired from business twenty years ago.

MR. THOMAS REID, of the firm of Thomas Reid & Son, engineers, Paisley, died on June 12, in his 87th year. The deceased founded the business in 1877, but retired from the active management a few years ago.

MR. E. SUGG WRIGHT, of Wm. Sugg & Company, Limited, engineers, Regency Street, Westminster, London, S.W., died recently at the age of 51 years. He had been connected with the company for about thirty-six years, and steadily rose in the service of the firm.

After a brief illness Mr. George Robertson, founder of the firm of George Robertson & Sons, coppersmiths, brass founders, and electricians, Snawdoun Works, Paisley, died on June 16, at his residence, Dunara, Whitehaugh Drive, Paisley. Mr. Robertson, who was in his 83rd year, had occupied a prominent position in business circles for over half a century.

THE partnership hitherto subsisting between Messrs. M. J. Stephan and M. C. Carr-Gomm, carrying on business as consulting and mechanical engineers at 6, Broad Street Place, London, E.C., under the style of Stephan & Carr-Gomm, has been dissolved.

THE members of the Ipswich Engineering Society recently paid a visit of inspection to Messrs. Turner's new foundry at Grey Friars' Works. The company were received by Mr. Leonard Turner, Mr. F. W. Turner, and some of the chief members of the staff.

A MEETING of the creditors of Bever, Dorling & Company, Limited, will be held at Bowling Iron Works, Bradford, on Friday, July 21, to receive the report of the liquidator, showing how the winding-up of the company has been conducted and its property disposed of.

THE partnership subsisting between Messrs. A. Bundy, S. A. Bundy, and H. J. Cogger, carrying on business as general engineers and machinists, at Newport, Isle of Wight, under the style of the Lukely Engineering Company, has been dissolved so far as S. A. Bundy is concerned.

THE shareholders of James B. Petter & Sons, Limited, will meet at 131, Edmund Street, Birmingham, on Friday, July 14, for the purpose of having the liquidator's accounts, showing the manner in which the winding-up has been conducted and the property of the company disposed of, laid before them.

THE Secretary of State for the Home Department has given notice, pursuant to section 80 of the Factory and Workshop Act, 1901, that he has amended the draft regulations for the smelting of materials containing lead, etc., and that he proposes to make regulations in accordance with the amended draft.

THE partnership heretofore subsisting between J. E. Hackett, of Fairhurst Street, Liverpool, carrying on business as engineers and brassfounders, at 6 & 8, Fairhurst Street, Liverpool, under the style of H. O. Andrews & Company, has been dissolved. In future the business will be carried on by Mr. J. Wall.

THE incorporation of the Canadian branch of Vickers, Limited, is announced from Montreal, the capitalisation being placed at $5,000,000. The incorporators are Mr. Albert Vickers (chairman), Sir Arthur Trevor Dawson, Sir Vincent Penlaver Caillard, Mr. F. O. Lewis, Mr. J. G. Lewis, Sir Hugh Montagu Allen, and Mr. P. Macintosh, Montreal.

THE partnership heretofore subsisting between Messrs. W. B. Railton, R. Campbell, and J. F. Crawford, carrying on business as engineers, iron founders, and manufacturers of patent specialities, at Washington Foundry, Cherry Lane, Walton, Liverpool, under the style of Railton, Campbell & Crawford, has been dissolved. In future the business will be carried on by Campbell and J. F. Crawford under the same name.

THE first meeting of the creditors of A. D. Furse (lately trading at the Southwark Engineering Works), of Boundary Lane, Walworth, London, S.E., was held on June 9 at the Bankruptcy Buildings, Carey Street, W.C., Mr. W. G. Williams, Assistant Official Receiver, presiding. The chairman reported that no statement of affairs had yet been lodged by debtor, but he estimated his liabilities at £1,600, and valued his assets at £240. No resolution was passed, and the case accordingly remained in the hands of the Official Receiver as trustee for administration.

WELLMAN, SEAVER & HEAD, LIMITED, have been awarded the order from Alfred Hickman, Limited, of Bilston, Staffs., for their first open hearth steel plant. The plant is being commenced with a 40-ton basic lined furnace, served by a 75-ton ladle crane for tapping into ingot moulds, and also charging machinery for dealing with both liquid and solid material. The whole plant, including the furnace and important machinery connected with it, is being supplied by Messrs. Wellman, Seaver & Head.

W. T. GLOVER & COMPANY, LIMITED, Trafford Park, Manchester, inform us that owing to the resignation of their Mr. Scott, of Glasgow, who has represented them for many years past, they have appointed Mr. McEwan, who has for a considerable period represented them in the East of Scotland, as their sole resident representative for the whole of Scotland. The company are continuing their branch establishments at 196, St. Vincent Street, Glasgow; and 9, Clyde Street, Edinburgh.

RECENT orders for foundry plant received by the London Emery Works Company, Park, Tottenham, N., include a complete hydraulic moulding machine plant for making castings for kitchen ranges and a complete sand preparing plant for Brisbane, two hydraulic moulding machines for stove work for Christchurch, two pulley moulding machines and a sand mixer for Japan, one portable mould drying stove for Manchuria, two turnover hand-ramming moulding machines, one sand mixer, and one core oven for Buenos Aires, two portable sand blast apparatus for removing scale from ships' bottoms, and one flat-table hand-ramming moulding machine for large plates for Brazil.

THE sixth congress of the International Association for Testing Materials will be held in New York City and in Washington in the beginning of September, 1912. Six days have been allotted to the sittings, and arrangements will also be made for members to take part in the deliberations of the Congress for Applied Chemistry. In connection with the Congress excursions will take place, which will likewise last about six days. This Congress, for which a large number of papers have already been promised, and which will be held under the auspices of the American Society for Testing Materials, promises remarkable results in every respect. The president of the International Association, Professor Henry M. Howe, will act as President of the Congress, the secretarial duties being in the hands of Professor Edgar Marburg, of Philadelphia.

AT the conference of the Institution of Civil Engineers on Education and Training of Engineers, which was held on June 28 and 29, under the chairmanship of Mr. Alexander Siemens, the details of the sectional meetings were as follows:—Wednesday, June 28—Sections I. and II. (joint meeting): Chairman, Mr Anthony G. Lyster, Vice-President Inst. C.E. Discussions: "The extent to which mathematical and scientific subjects should share with other subjects of literate education the attention of schoolboys who intend to enter later the engineering profession," introduced by Dr. J. Gow and Prof. Silvanus Thompson; "The question of specialised entrance examinations for university or college courses of study in engineering science with a view to the curricula to be followed, and also of the inclusion in the latter of courses in modern languages," introduced by Prof. A. K. Schwartz. Section III.: Chairman, Mr. R. Elliott-Cooper, Vice-President Inst. C.E. Discussions: "The requirements of practical training and of scientific study and the apportionment of time to them," introduced by Mr. A. F. Yarrow and members of his staff, and Mr. W. H. Allen; "Practical training in workshops or on works of construction, with special reference to training in the engineer's office," introduced by Mr. W. B. Worthington and Mr. H. F. Donaldson. Thursday, June 29—Section II.: Discussions: "The value of a university degree in engineering science in relation to professional competence." introduced by Prof. S. M. Dixon and Prof. C. F. Jenkin; "The position and uses of engineering laboratories in relation to education at college," introduced by Prof. W. E. Dalby, Prof. John Goodman, and Prof. Bertram Hopkinson. Sections II. and III. (joint meeting)—Chairman, Dr. W. C. Unwin, B.Sc., F.R.S., Vice-President Inst. C.E. Discussion: "The relation of engineering employers and colleges from the point of view of the practical training of college students," introduced by Prof. J. E. Petavel and Mr. J. W. Horne. Section III.—Discussions: "The relation of practical training to college study; whether, or to what extent, before, sandwiched, or after its conclusion," introduced by Prof. Archibald Barr and Prof. Henry Louis; "Workshop training as a preliminary to practical training in other branches of engineering" introduced by Mr. John A. Brodie, Mr. J. Mitchell Moncrieff, and Prof. J. J. Welch.

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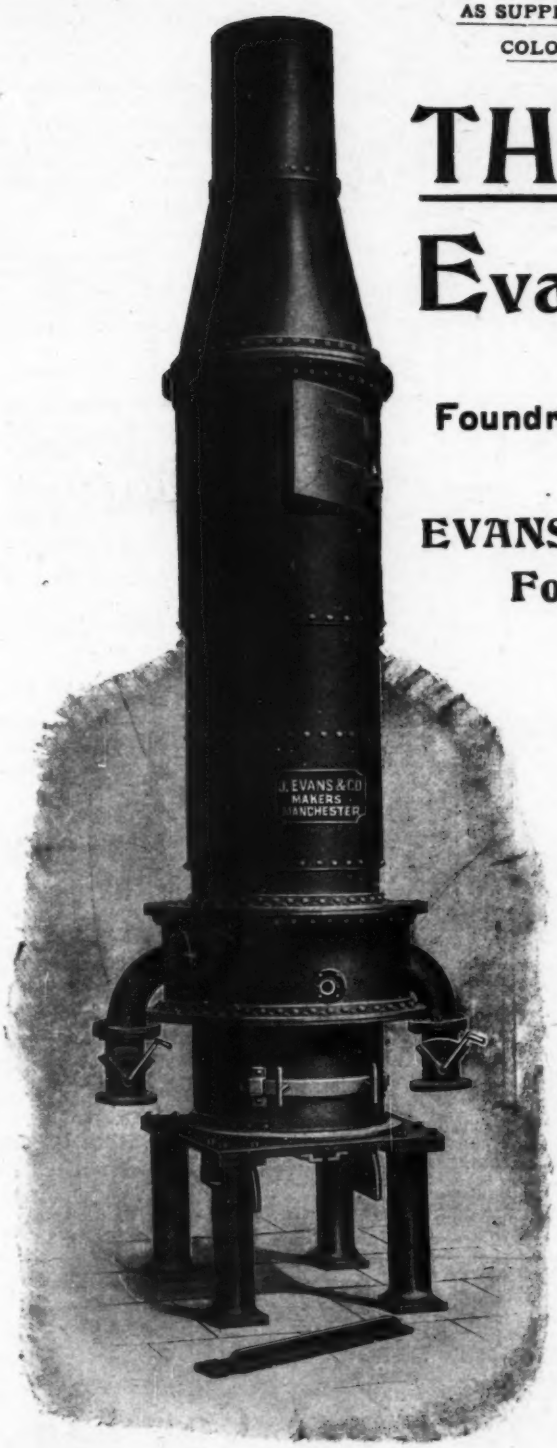

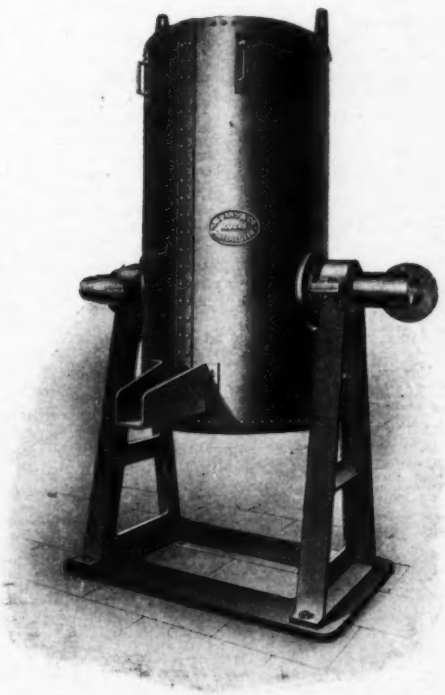

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New Companies.

THOMAS TRY & SON, LIMITED.—Capital £2,000 in £1 shares, to carry on the business of engineers, etc.

KJELLBERG SYNDICATE, LIMITED.—Capital £130 in £1 shares, to carry on the business of electric welders, etc.

HENRY SMETHURST & SONS, LIMITED.—Capital £3,000 in £1 shares, to carry on the business of engineers, etc.

CENTRAL ENGINEERING COMPANY, LIMITED.—Capital £2,000 in £1 shares. Registered office: 5-, Sherbourne Road, Birmingham.

MACFARLANE ENGINEERING COMPANY, LIMITED.—Capital £5,000 in £1 shares. Registered office: 138, West Regent Street, Glasgow.

R. E. ROSS & SON, LIMITED.—Capital £10,000 in £1 shares. Registered office: Greenhead Engine Works, Cumberland Street East, Glasgow.

S. MANSEL JONES, LIMTED.—Capital £4,000 in £1 shares, to carry on the business of engineers, etc. Registered office: 63, Wind Street, Swansea.

PARSONS, HARVEY & COMPANY, LIMITED.—Capital £500 in £1 shares, to carry on the business of engineers, etc. Registered office: 19, Cazenove Road, Stoke Newington, N.

WILDT & COMPANY, LIMITED.—Capital £50,000 in £1 shares (10,000 preferred), to carry on the business of engineers, etc. Registered office: Adelaide Works, The Newarke, Leicester.

LEWIS & SMITH, LIMITED.—Capital £2,000 in £1 shares, to take over the business carried on by F. H. Lewis and D. Smith, as the Leve Foundry Company, at Walsall Street, Willenhall.

QUIRK, BARTON & COMPANY, LIMITED.—Capital £120,000 in £1 shares (40,000 5 per cent. cumulative preference), to carry on the business of lead manufacturers and rollers, smelters, etc.

STEWARD & SOWDEN, LIMITED.—Capital £1,000 in £1 shares, to take over the business of an engineer, millwright, etc., carried on at Town End, Gildersome, by Mr. O. Sowden, as Steward & Sowden.

T. C. AVELING & COMPANY (BIRMINGHAM), LIMITED.—Capital £2,500 in £1 shares, to take over the business of engineers, agents, etc., formerly carried on by T. C. Aveling & Company at New Canal Street, Birmingham.

JAMES J. GUEST & COMPANY, LIMITED.—Capital £20,000 in £1 shares, to adopt an agreement with J. J. Guest for the acquisition of the business of a mechanical and electrical engineer and manufacturer of grinding machines.

A. KINGHORN & COMPANY, LIMITED.—Capital £3,000 in £1 shares, to take over the business of an engineer, tool maker, and machinery merchant, carried on by Betsy Kinghorn, at the Phœnix Punch and Shear Works, Todmorden, as A. Kinghorn & Company.

ELECTRO FLEX STEEL COMPANY, LIMITED.—Capital £25,000 in £1 shares, to acquire any inventions relating to electric furnaces, the electrical smelting of ores, and the refining of metals, or to electric batteries, electro-chemical or electro-thermal processes, etc. Registered office: 86, Collingwood Buildings, Collingwood Street, Newcastle-on-Tyne.

Legal.

Muntz's Metal Company v. The London and North Western Railway.

Mr. Justice A. T. Lawrence, the Hon. A. E. Gathorne-Hardy, and Sir James Woodhouse, sitting in the Railway and Canal Commission, last month, delivered judgment in the application by Muntz's Metal Company, Limited, against the London and North-Western Railway Company. The applicants complained that they had to contend with severe competition from other manufacturers in the Birmingham district and other places, and that the rates which they were charged for the carriage of their goods included charges for additional services and accommodation that were not provided for them. They said they had been

(*Continued on page 422.*)

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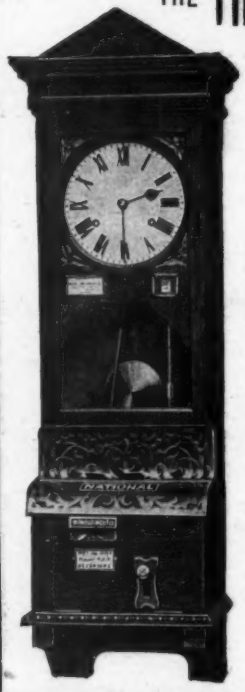

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The following, selected from numerous letters, are eminent testimony as to the quality of our celebrated "A.A.A." Coppee Foundry Coke, carefully selected, and despatched in sheeted wagons.

From PECKETT & SONS, Bristol.

Bristol, October 25th, 1904.

We have been using your Selected Foundry Coke for some considerable time.
We have pleasure in stating that we are very pleased with it, as we find we get sounder and cleaner castings, mor free from blowholes and other defects, than we formerly did.

From BOW, McLACHLAN & CO., LTD. (Paisley Foundry), Paisley, Glasgow.

Paisley, 12th March, 1909.

We have yours of 4th inst., and in reply have pleasure in stating that we have been using your Foundry Coke for several years for special purposes with highly satisfactory results.

Elders Collieries, Ltd., Cardiff.

overcharged in this respect. They also alleged that competitive traders had been unduly preferred by the railway company and claimed rebate in respect of their traffic during six years prior to the date of the application.

Mr. A. E. Gathorne-Hardy, who delivered the judgment of the Court, said the applicants had sidings adjacent to the railway at Soho, Birmingham, and complained that the rates they were charged in respect of traffic for these sidings were those charged by the railway company to and from Soho Station in respect of the goods of other traders who had no private sidings. The applicants regarded it as extravagant that they should be charged for a siding service at a rate charged by the railway company to other traders for terminal service at the station. There could be no question, said Mr. Gathorne-Hardy, as to the substantial character and importance of the traffic, and, in the opinion of the Court, the applicants were entitled to rebate. The calculation of what that rebate should be was a difficult one, and the Commissioners could only arrive at the allowance to be made by taking into account the money value to the company of services rendered at the station and deducting therefrom the value of services rendered at the sidings. This worked out at 2d. per ton on coal and goods in what was known as Class A and 6d. per ton on other goods. On the point of undue preference, the Court held that the applicants must fail, except in regard to Derby, Crewe, and Leeds. In regard to those places the applicants were entitled to say that the rates charged constituted undue preference.

Mr. Talbot, K.C., for Muntz's Metal Company, said the question as to how far back allowance was to be made had not, apparently, been dealt with in the judgment. At an early stage in the proceedings his clients adduced evidence to prove that the rates, except those of London, were not published, and under these circumstances he submitted that his clients were entitled to whatever relief the Court awarded on the point of undue preference for six years before the date of the application.

After some argument the Commission decided that the point might be raised on some future occasion.

PRICES OF METALS.

The following table shows the approximate latest prices and position of stocks of metals during the past wo years :—

METALS.	End June, 1911.	End June, 1910.
Iron—Scotch pig warrants ton	*52/3	*55/3
—Middlesbro' warrants .. ton	46/4	49/3
—W.C. M/nos Bessemer ... ton	63 0	67 6
—Stock, Scotch ... ...tons	1,000	1,000
Copper—Chili bars, GMB ton	£57 0 0	£55 2 6
—Stock, Europe and afloat tons	—	†105,371
Tin—English ingots ... ton	£196 10 0	£147 10 0
—Straits ... ... ton	£197 5 0	£148 5 0
—Stock, London, Holland, U.S.A., and afloat ...tons	17,121	16,452
Lead—English pig ... ton	£13 15 0	£13 2 6
Spelter—Ord. Silesian ... ton	£24 15 0	£22 0 0
Quicksilver (75lb)... bottle	£8 7 6	£8 15 0
Antimony—Regulus ... ton	£29 10 0	£29 10 0 £30 10 0

* Settlement price. † June 15.

CASTINGS.

In the Cleveland district the following are the nominal rates current for castings :—

	£ s. d.		£ s. d.
Columns (plain)	6 10 0	to	6 15 0
Pipes, 1½ to 2½ in.	4 17 6	to	5 2 6
,, 3 to 4 in.	4 10 0	to	5 0 0
,, 5 to 8 in.	4 7 6	to	4 10 0
,, 10 to 16 in.	4 7 6	to	4 10 0
,, 18 to 24 in.	4 7 6	to	4 10 0
Chairs	3 12 6	to	3 15 0
Floor plates (open sand)....	2 17 6	to	3 0 0

SCRAP.

The quotations for scrap, subject to market fluctuations, are as follows :—Heavy wrought (mixed), £2 9s. 0d.; light wrought, £1 5s. 0d.; heavy cast, £2 6s. 0d.; all per ton, f.o.b., London. Copper (clean), £53 10s. 0d.; brass (clean), £39 0s. 0d.; lead (usual draft), £12 10s. 0d.; zinc, £19 15s. 0d.; all per ton delivered merchant's yard.

Pulveriser

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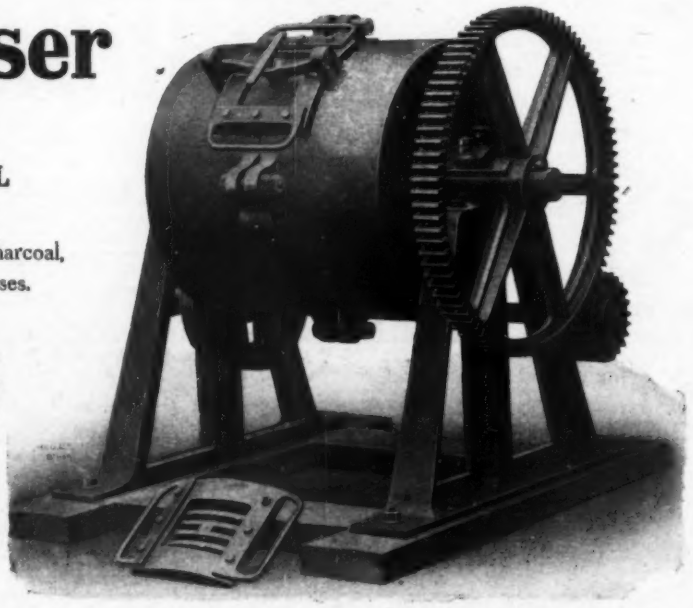
For grinding Coal Dust Charcoal, &c., for Foundry purposes.

Grinds coal-dust to any degree of fineness—makes smoother castings, and saves time in dressing and fettling.

Illustrated price list on application.



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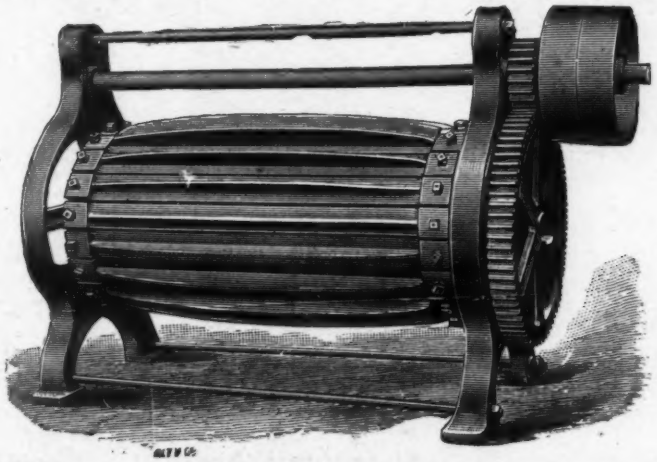
Ladles, Cupolas, Fire Bricks, Gannister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

Improved Foundry Rattler or Fettling Drum.



These Machines are invaluable for a Foundry, doing a larger amount of work of a superior quality, in a much shorter time than can be done by hand, without skilled labour.

The following testimonial explains itself :—

"Dear Sirs,—We have been using your best Blacking for a large number of years, and always use it on our large Ingot Moulds, which, as you know, we have made up to 85 tons in weight.

Yours faithfully, THE BRIGHTSIDE FOUNDRY & ENGINEERING CO., LD."

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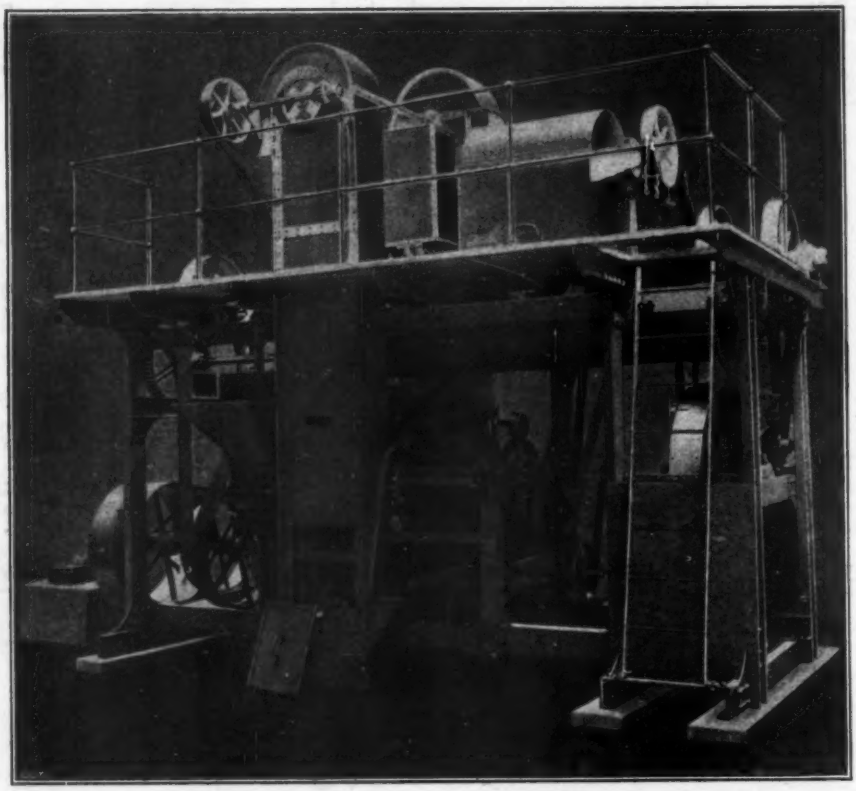

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Air Compressors (Belt).
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Marshall & Co., Horace P.
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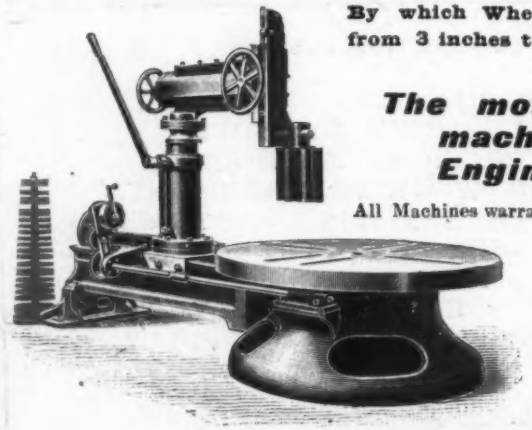

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486	Jones & Attwood, Ltd.	Stourbridge	Heat, Stourbridge	10, Stourbridge
437	Keith, James, & Blackman, Co., Ltd.	27, Farringdon Avenue, London	James Keith, London	6194 H'lb'rn(4 lines
436	King, Bros. (Stourbridge), Ltd.	Stourbridge	King Bros., Stourbridge	—
488	London Emery Works Co., Ltd.	Park, Tottenham	Naxium, London	99 Tottenham
482	Lowood, J. Grayson, & Co., Ltd.	Deepcar, nr. Sheffield	Lowood, nr. Sheffield	18 Stocksbridge
435	Macdonald, J. & Son, Ltd.	Maryhill, Glasgow	Compressor, Glasgow	161 Mary Hill
482	Mansergh, T. E.	Wheathill Charcoal Works, Salford	—	—
	Marshall, H. P., & Co.	Leeds	Specialty, Leeds	909 Leeds
433	Metalline Cement Co.	112, Bath Street, Glasgow	Adhesive, Glasgow	201Y2 Douglas
433	Mitchell's Emery Wheel Co.	Bradford, Manchester	Diameter, Manchester	Central, 3575
432	McNeil, Chas.	Kinning Park, Glasgow	McNeil, Glasgow	X 155
	National Time Recorder Co.	5, Blackfriars Road, E.C.	Natrecord, London	918 Hop
430	Olsen, William	Cogan Street, Hull	Wm. Olsen, Hull	599 Y.I.
	PhillipsChas. D.	Newport, Monmouthshire	Machinery, Newport	18 & P.O. 576
430	Phillips J. W. & C. J.	23, College Hill, E.C.	Colloquial, London	10112 Central.
C. iii.	Piasti-Kion Co., The	Caxton House, S.W.	—	—
437	Portway, C. & Son	Halstead, Essex	Portway, Halstead, Essex	10 P.O. Halstead
C. iii.	Robeson Process Co.	17, Fenchurch Street, E.C.	Sprudel, London	6045 Bank
438	Samuelson & Co., Ltd.	Banbury	Samuelson, Banbury	—
436	Silent Machine Co.	Albion Works, Sallie St., Sheffield.	Forward, Sheffield	—
429	Standard Sand Co., Ltd.	Mansfield	Standard Sand Co., Mansfield	201 Mansfield
435	Stewart, D., & Co. (1902) Ltd.	London Road Ironworks, Glasgow	Stewart, Glasgow	71 P.O.Bridgt'n & 3243 Bridgton(N)
432	Stockall Brook Time Recorders, Ltd.	43, Market Street, Huddersfield	—	1069 Huddersfield
430	Sykes, James	Ashton-under-Lyne.	—	—
483	Thermit, Ltd.	27, Martin's Lane, E.C.	Fulmen, London	3749 Central
492	Tilghman's Patent Sand Blast Co., Ltd.	Broadheath, nr. Manchester	Tilghmans, Altrincham	14
439	Thwaites Bros., Ltd.	Bradford	Thwaites, Bradford	325 Bradford
	Vaughan & Sons, Ltd.	West Gorton, Manchester	Vaunting, Manchester	5113 Central
436	Walker, I. & I.	Rotherham	—	—
492	Whittaker, W., & Sons, Ltd.	Oldham	Whittakers, Engineers, Oldham	83
433	Wilkinson, Thos., & Co., Ltd.	Middlesbrough	Blacking, Middlesbro.	419
430	Williams, J. (B'ham Sand) Ltd.	Birmingham	—	—

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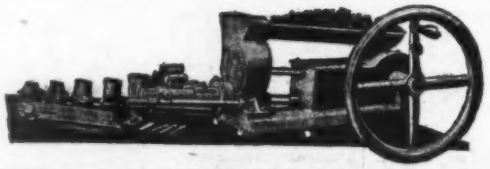
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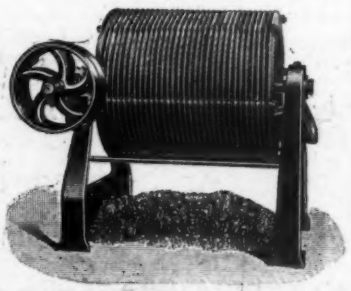
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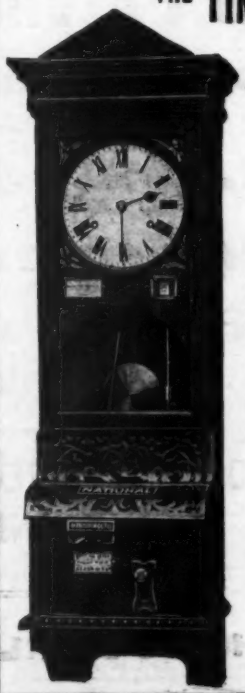

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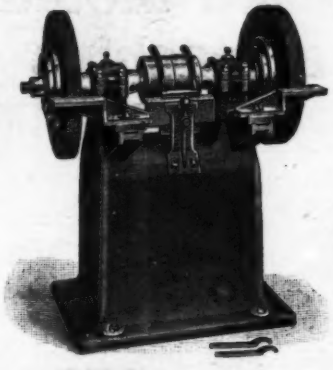

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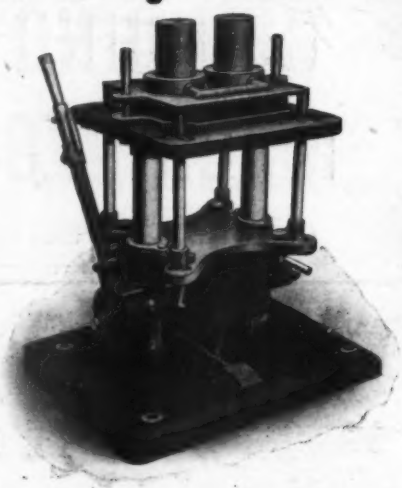

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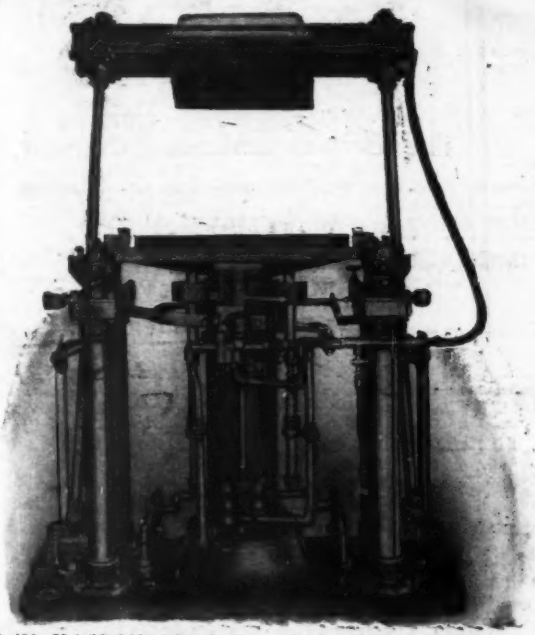

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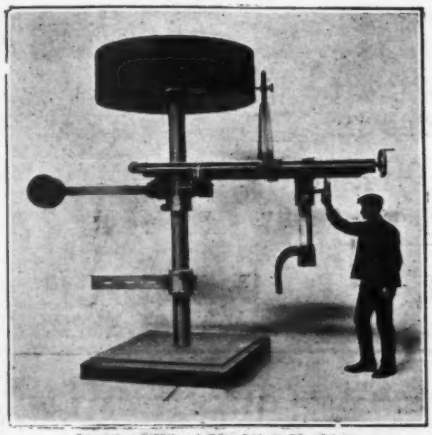

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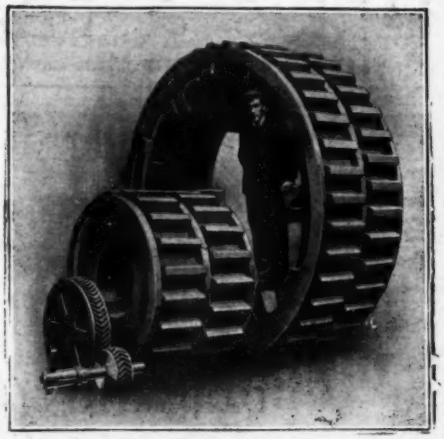

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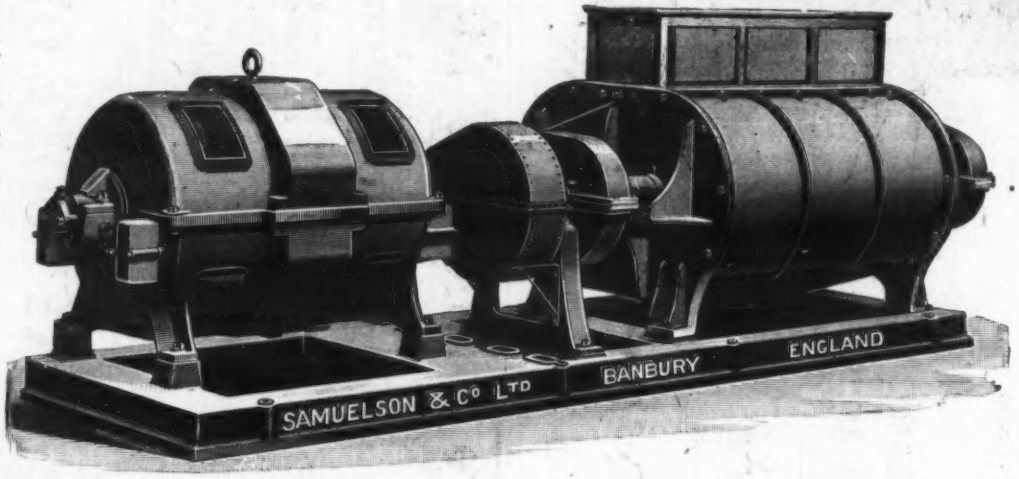

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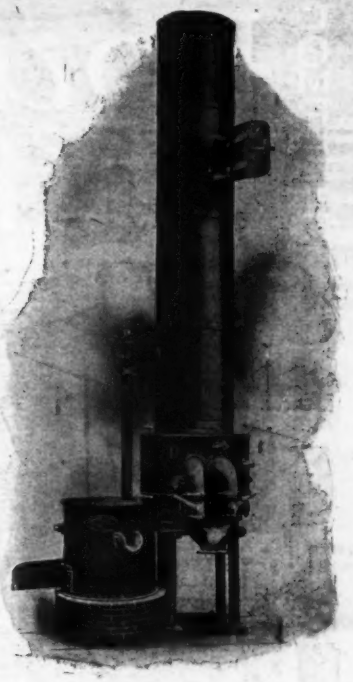

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